

**THE DETERMINATION OF OPERATIONAL AND
SUPPORT REQUIREMENTS AND COSTS
DURING THE CONCEPTUAL DESIGN
OF SPACE SYSTEMS**

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INTERIM REPORT

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THE DETERMINATION OF OPERATIONAL AND SUPPORT REQUIREMENTS AND COSTS DURING THE CONCEPTUAL DESIGN OF SPACE SYSTEMS

INTERIM REPORT

I. Introduction

The primary objective of this research is to develop a methodology for predicting operational and support parameters and costs of proposed space systems. This report addresses the first phase of this study which consists of: (1) the identification of data sources; (2) the development of a methodology for determining system reliability and maintainability parameters; (3) the implementation of the methodology through the use of prototypes; and (4) support in the development of an integrated computer model. This report documents the phase I results and identifies a direction to proceed to accomplish the overall objective.

II. Related Studies

Several previous studies provide insight and motivation for this research. These studies are discussed briefly below. Other research relevant to the second phase of this effort will be included in the final report.

The Supportability Assessment Model (SAM) developed by Rockwell International [18] provided much of the motivation for the development of the parametric equations as part of this research. Unfortunately, SAM is a proprietary model which restricts its availability. Only limited documentation may be found on the model. However, SAM does project maintenance action rates as a function of the dry (empty) weight of a vehicle. Dry weight is considered a surrogate for complexity. This projection is then modified by factors which consider the environment (e.g. space vs ground), technology (development year) and reliability procurement policies (high or low reliability specifications). Using Air Force Maintenance Data Collection (MDC) data (AFM 66-1) pertaining to the C-9A, C-141A and the C-5A, Rockwell derived a regression equation with maintenance actions per flying hour as a dependent variable and empty weight as an independent variable. Predictions from this equation for estimating spacecraft reliability are then adjusted by an environmental factor derived from MIL-HDBK-217, Reliability Prediction of Electronic Equipment and a technology factor related to the development year.

What appears to be an enhancement to the original Rockwell SAM model is the Reliability/Maintainability (R/M) Analysis Methodology used by Rockwell in assessing the R&M of the Personnel Launch System, Advanced Manned Launch System (PLS/AMLS). [16] This analysis established regression equations between unscheduled maintenance actions and vehicle dry weight for several aircraft subsystems such as avionics, powerplants, electrical, hydraulic, structural and landing gear. Eight different aircraft including a bomber,

fighters and airlift (cargo) are used to generate examples of the correlations obtained between subsystem weight and maintenance actions per flying hour or per landing. Component removals are computed as a percent of the component maintenance actions in order to determine requirements for spares. Both a bottom-up and a top-down analysis is performed using Air Force, airline and orbiter data.

In a discussion on life cycle costing, Earles [6] presents one of the first successful parametric models for estimating maintenance manhours per flying hour (MH/FH). An estimate of the MH/FH for on-aircraft propulsion is obtained from a regression equation with the thrust/engine and number of engines as independent variables. Five tactical aircraft and the T-38 provided the source of data.

Another early study by Harmon, Pates, and Gregor [8] developed maintenance manhour per flying hour (MH/FH) estimates for tactical aircraft for use during conceptual and development design phases. Again, using AFM 66-1 data, MH/FH estimating relationships were derived using aircraft design and performance parameters. Using ten tactical aircraft, a data base covering maintenance manhours over a 6 month period was developed at the two-digit work unit code (WUC). Different independent variables were selected for each subsystem. For example, landing gear maintenance manhours was assumed to be related to kinetic energy and aircraft weight while the fuel system maintenance manhours was related to weight, number of engines and fuel quantity. Correlations above .90 were reported for each of the examples, however, only 5 to 7 data points (aircraft) were used in the analysis. Technology improvement factors are given for each WUC but details on their derivations are not provided.

Norris and Timmins [13] present another early study which focused on spacecraft performance during its orbital life. Component failure rates over time of 57 unmanned spacecraft were analyzed. Both a Duane reliability growth curve and a Weibull hazard rate function provided an adequate fit to the data. A decreasing failure rate over time was observed from the data during the first day following launch.

Decreasing failure rates were also reported in a study by Hecht and Florentino [9] and Hecht and Hecht [10] which focused on electronic systems of over 300 spacecraft. The study concluded that design and environmental causes of failures contributed the most to a decreasing failure rate. They computed Weibull shape and scale parameters for each of several failure classifications. Causes of spacecraft failures, their distribution by subsystem and criticality and mission type are also presented. A reliability prediction method is developed for electronic equipment operating in a space environment which is consistent with MIL-HDBK-217.

Peacore [15] discusses some reliability results pertaining to the Air Force's AWACS (E-3A) system. In flight failure rates were found to be decreasing with flight time which he believes to be characteristic of large multi-engine transport type aircraft. A model, developed by Boeing Aerospace Corporation and based upon B-52 data, has high early failure rates which decrease to a relatively constant rate after 10 hours of flight. The high early failures are attributed to environmental stresses during takeoff, failures occurring when initiating (e.g. turning on) and stabilizing equipment, failures undetected during testing, and maintenance induced failures.

One of the few papers addressing failure time and repair time probability distributions is presented by Ostrofsky.[14] However, only graphical examples of these distributions are provided with no results on fitted theoretical distributions reported.

A comprehensive report prepared for the Goddard Space Flight Center (NASA) by Bloomquist and Graham [4] describes the study of 44 unmanned orbital spacecraft. In fact, this study is an update of earlier studies conducted by the Planning Research Corporation (PRC) which addressed 350 spacecraft. In addition to providing an extensive data base of the 44 spacecraft, the report classified anomalies by satellite mission, subsystem, effect, and incident type (e.g. electrical or mechanical). Subsystem survival times were also computed in units of the spacecraft design life.

A report prepared by Hughes Aircraft for the Rome Air Development Center [12] addresses differences between predicted and demonstrated reliability and the observed field values (primarily MTBF). Prediction models for estimating the field MTBF were derived. The study contains a detailed description of the Air Force's MDC (AFM 66-1) and D056 data systems. The relationship between predicted and observed MTBF was established using multiple regression techniques. Of interest in this report is the derivation of a "K" factor (equipment use factor) to account for the differences between equipment flying hours and equipment operating hours. Equipment operating hours varied from 1.2 to 2.4 times the flying hours depending upon the aircraft.

Maintenance policies may have a significant effect on the maintenance manhours expended in supporting a space vehicle. Barnard and Matteson [3] describe a test conducted by the Navy to perform aircraft maintenance similar to that of the commercial airlines. Both scheduled maintenance manhours and aircraft downtime were significantly reduced while the quality of maintenance increased. Similar changes in maintenance policies may be contemplated as NASA transitions from the shuttle to the next generation of space transportation vehicles.

III. Data Sources

The principle approach to be used in establishing R&M estimates of new space systems is based upon comparability with existing systems. In this regard, many of the subsystems defined for manned space vehicles may be favorably compared to corresponding aircraft systems. Therefore, a primary source of data to support this analysis would be obtained from both commercial and military aircraft failure and repair data.

A. Categories of data.

The primary R&M data sought are:

(1) Time between maintenance. This is the length of time in flying hours or sorties between maintenance actions on a particular subsystem or component. Both scheduled and unscheduled maintenance actions may be included. Unscheduled time between failures is usually characterized by the Mean Time Between Failures (MTBF).

(2) Maintenance manhours per flying hours (MH/FH). This is sometimes referred to as the maintenance index (MI) and may be broken down into off-equipment (aircraft) and on-equipment (aircraft) manhours.

(3) Maintenance Task Times. The length of time (usually in hours) to perform a particular task such as troubleshoot, remove and replace, perform minor maintenance, etc. This maintainability parameter is usually summarized at the subsystem or component level as the Mean Time to Repair (MTTR).

(4) Maintenance crew sizes. The number of maintenance personnel required to perform a particular task. This number may vary depending upon the task, the particular component involved and the skill level of the personnel.

This data should be categorized by subsystem and/or component or Line Replaceable Unit (LRU) and aircraft type. Figure 1 identifies the major subsystems (2-digit work unit codes).

Figure 1

Air Force Work Unit Codes (WUC)

2-Digit Level

WUC
SYS SYSTEM NOUN

03	*SCHED INSP LOOK PH
04	*SPECIAL INSP
11	STRUCTURES
12	EQUIP/FURNGS
13	LANDING GEAR
14	FLIGHT CONTROLS
23	POWER PLANT SYSTEM
24	AIRBORNE AUXY PWR
41	AIR CONDITIONING
42	ELECTRICAL POWER
44	LIGHTING SYSTEM
45	HYDRAULIC POWER
46	FUEL SYSTEM
47	OXYGEN
49	FIRE PROTECTION
51	INSTRUMENTS
52	AUTO FLIGHT
61	COMMUNICATIONS
62	*VHF COMMUNICATIONS
63	UHF SYSTEM
64	PASS ADDRESS SYS
65	*IFF
66	EMERG LOCT XMTR
68	*AFSAT COMM
69	*MISC COMM EQ
71	NAVIGATION
72	RADAR NAVIGATION
91	*EMERG EQUIP
97	*EXP DEV & COMP

B. Military Data Systems

1. US Air Force

Reliability and maintainability data for USAF aircraft originates with the Maintenance Data Collection (MDC) system as described in AFM 66-1. This data is collected at the base (squadron/wing) level (AFTO Form 349) and transmitted periodically to AF Logistics Command (AFLC). AFR 65-110 data (aircraft status reporting) reports flying hours and sorties for the same bases monthly. The D056 Product Performance System processes this data producing several R&M reports. D056 also provides data to the Maintenance and Operational Data Access System (MODAS) for on-line viewing and retrieval. ALD Pamphlet 800-4, Aircraft Historical Reliability and Maintainability Data summarizes the worldwide R&M data at the two-digit work unit code (WUC) in 6-month intervals (see Appendix A for an example). Currently Volumes I through VI covering the years 1972 through 1989 have been published.

The current OPR for ALD 800-4 is ALD(AFLC)/LSR, Wright-Patterson AFB, Ohio. However, with the consolidation of AFLC and the Air Force Systems Command (AFSC) scheduled for July 1992, this office may no longer exist. With the eventual implementation of REMIS (Reliability and Maintainability Information System), the D056 system along with MODAS will also be eliminated. It is not certain at this time what the final configuration and capabilities of REMIS will be.

The MODAS system (G063) is currently sponsored by AFLC/MMES, Wright-Patterson AFB, Ohio 45433. MODAS provides the user with access to various data bases through an interactive menu driven system. It is a Data Base Management System (DBMS) with some automated analytical capability. R&M information may be displayed by aircraft (MDS), WUC, level of WUC, base and by month. Examples of output products relevant to this research are provided in Appendix B.

In addition, to the above systems, a unique representation of aircraft R&M data exist in the form of Logistics Composite Model (LCOM) data bases. LCOM is a computer simulation model which simulates the operation of a squadron or wing of aircraft with random failures times and repair times of aircraft subsystems and components. LCOM data bases exist for most of the aircraft in the Air Force inventory although many of these data bases are several years old. This data is unique in that the failure times may be based upon several years of (AFM 66-1) data and repair times and crew sizes are often based upon field audits conducted at the unit's themselves. This data, which is usually collected at the 3 or 4 digit WUC level, is a refinement of the MDC data. Appendix C contains examples of the LCOM data forms. Most LCOM data bases may be obtained from ASD/ENSSC, Wright-Patterson AFB, Ohio.

2. US Navy

The primary source of R&M data pertaining to Navy aircraft is the Aviation 3-M Information reports. The Navy Maintenance Support Office (NAMSO), is the central data bank for Aviation 3-M data. NAMSO is part of the Naval Sea Logistics Center. Although preformatted reports are published monthly, quarterly and annually, and are available on request, a potential user may also request the development of a new report. Most reports can be obtained on either hardcopy or microfiche. Magnetic tape may be obtained under a special request.

The following R&M reports have been identified as relevant to this research. Examples of each report may be found in Appendix D.

<u>Report Title</u>	<u>Report Number</u>
Reliability and Maintainability Summary	NAMSO 4790.A7142-01
WUC System R&M Summary	NAMSO 4790.A7142-02
R&M Summary for selected WUCs	NAMSO 4790.A7142-03
R&M Trend Analysis Summary	NAMSO 4790.A7142-04
5-Digit WUC R&M Trend Analysis Summary	NAMSO 4790.A7142-05
R&M Summary for Selected Equipments	NAMSO 4790.A7298-01

The R&M Summary Report provides data similar to that available from the MODAS system. Summary statistics are reported by aircraft type at the 5-digit WUC and include mean flying hours between maintenance actions, maintenance manhours per flying hour, maintenance manhours per maintenance action, and elapsed maintenance time per maintenance action.

Of particular interest in this research is the WUC System R&M Summary. This report provides mean flying hours between maintenance actions, maintenance manhours per flying hour, maintenance manhours per maintenance action, and elapsed maintenance time per maintenance action by system level WUC (2-digit) for all appropriate aircraft. Similar R&M information is provided in the R&M Summary for selected WUCs. However, this report is at the 4-digit WUC and pertains only to engines and avionic components.

The two trend analysis reports provide MTBF and MH/FH information at the 4-digit and 5-digit WUC respectively. Multiple time periods may be displayed to produce trend data, and a comparative failure ranking of the WUC relative to all WUCs for the aircraft is computed.

The final report, R&M Summary for Selected Equipments, allows for R&M data to be presented at the 2nd and 4th level WUC by activity. This report would not add any new information not already available on the other reports other than the activity breakdown.

3. Reliability Analysis Center

The Reliability Analysis Center (RAC) is one of 21 DOD Information Analysis Centers (IAC). It is operated by IIT Research Institute in Rome, New York. As an IAC, RAC maintains data bases and studies concerning component reliability particularly that of electronic systems. The Center also conducts special studies, publishes newsletters, and offers training courses. An example of one of RAC's data bases is contained in Appendix E. In general, the items contained in RAC's data bases are individual parts rather than an entire component. Therefore, this data may not be very useful in this research.

C. Commercial Aircraft

1. Federal Aviation Agency (FAA)

Commercial sources of R&M data include both the airlines and the aerospace contractors. In addition, the Federal Aviation Agency (FAA) in Oklahoma City maintains a data base consisting of component failures by Airline Transport Association (ATA) code which corresponds to the military's WUC. The data base is very detailed with significant variability in reporting by the individual airlines. A narrative on each incident is included, but there is no quantitative data for estimating MTBF or MTTR. A sample of the FAA records may be found in Appendix F. This data is of limited use since there is no practical way to obtain failure rates or times of failure without additional information.

2. Commercial Airlines

Each airline maintains R&M data in a form useful to them. Carrier A is recognized as having the most complete reliability data on aircraft currently in use. A sample report is included in Appendix G. Failures (removals) per 1000 unit hours are provided by component. We are also in the process of obtaining data from a second carrier. They maintain three possibly relevant reports: a component removal report, a monthly alert report, and a reliability report pertaining to their current aircraft. Airlines generally consider this data proprietary.

3. Aerospace Contractors

An example of the type of data maintained by the major aerospace corporations may be found in Appendix H. This report from Manufacturer A highlights subsystem failures which significantly affect scheduled flights resulting in delays (exceeding 15 minutes), flight cancellations, diversions, and air turn backs. While this information is very useful in identifying problem areas, failure times cannot be computed from this report. Scheduled interruptions are Boeing's major measure of reliability. They maintain very little data on MTBF, MTTR or maintenance MH/FH.

Manufacturer B maintains a Data Exchange Program contains various reliability reports. This information is provided to commercial aircraft customers. Information contained in this report is obtained from participating airlines. Like the Manufacturer report, it focuses on events which result in excessive delays and cancellations. However, a component removal summary contains some MTBF information. Appendix I provides examples of these reports.

5. Other Sources

A secondary source of reliability data consists of subcontractors involved in the manufacture of particular aircraft subsystems and components. For example, Hughes Corporation which, among other things, makes radar systems for various aircraft. We were able to obtain the system specifications and reliability test results on four of their radar systems (see Appendix J). As additional information like this on other radar sets is obtained, a parametric estimation of MTBF is possible. We have requested similar input from other subcontractors including Harris Corporation (digital map generators, global positioning system) and E- Systems (electronic systems). Others are anticipated during Phase II of this research.

Other sources which are being pursued include Airbus Industries (Europe), The Society of Automotive Engineers (SAE) which has published a guidebook on rocket booster reliability, the Aeronautical Systems Division (Air Force Systems Command) concerning a comparative study on competing radar systems, and the Air Force Logistics Command's Reliability and Maintainability Information System (REMIS). This list will be expanded as other relevant sources of R&M data are identified. This expansion will also include booster rockets and other space systems during Phase II.

Various points of contact for the data sources identified above are summarized in Appendix K.

IV. Methodology

The primary objective of this phase of the research is to develop a methodology for estimating reliability and maintainability parameters for use in life cycle costing, supportability requirements determination and the assessment of operational capabilities and constraints. This methodology must be based upon the available data sources identified above. The basic approach is to use comparability analysis. That is, spacecraft subsystem and component failures and repairs are assumed to be similar to those of comparable aircraft subsystems and components. Therefore, if we can estimate aircraft equipment failure and repair parameters as a function of performance and design specifications, then with suitable adjustments to account for the differences in operating environment, we should be able to estimate the R&M parameters of a conceptual space vehicle once certain design and operating specifications have been defined. Adjustments may also be necessary to account for technological innovations.

A. Regression Analysis

Parametric R&M equations may be derived using regression analysis. In general, letting

$$Y = B_0 + B_1 X_1 + B_2 X_2 + \dots + B_k X_k$$

where Y = R&M parameter of interest (e.g. MTBF)

and X_j = j th design or performance specification
(e.g. vehicle empty weight) $j = 1, 2, \dots, k$,

then

B_0, B_1, \dots, B_k are the regression coefficients.

These are estimated by performing a least-squares fit of the equation against known paired values for Y and the corresponding X_1, X_2, \dots, X_k .

The following R&M parameters are candidates for estimation using this approach:

MFH/MA - Mean Flying Hours between Maintenance Actions

MS/MA - Mean Sorties (Missions) between Maintenance Actions

ML/MA - Mean Landings Between Maintenance Actions

MMH/FH - Maintenance Manhours per Flying Hour

MMH/S - Maintenance Manhours per Sortie (Mission)

MMH/L - Maintenance Manhours per Landing

MMH/MA - Maintenance Manhours per Maintenance Actions

ON-MMH/MA - On-equipment Maintenance Manhours per Maintenance Action

OFF-MMH/MA - Off-equipment Maintenance Manhours per Maintenance Action

EMT/MA - Elapsed Maintenance Time per Maintenance Action (task time)

MCS/MA - Mean Crew Size per Maintenance Action

B. Mathematical Relationships

To estimate these parameters, it is necessary for the data system to maintain their historical values for each aircraft used in the analysis. Therefore, from a particular data source, it may only be possible to derive parametric equations for only a subset of these parameters. However, mathematical relationships among these parameters can be used. For example,

$$MS/MA = 1 / \{ [(1/MFH/MA) \times TOT FH] / TOT SORTIES \}$$

$$ML/MA = 1 / \{ [(1/MFH/MA) \times TOT FH] / TOT LANDINGS \}$$

$$MMH/S = MMH/FH \times TOT FH / TOT SORTIES$$

$$MMH/L = MMH/FH \times TOT FH / TOT LANDINGS$$

$$TOT MA = 1/MFH/MA \times TOT FH$$

$$MMH/MA = TOT MMH / TOT MA$$

$$ON-MMH/MA = (TOT ON-MMH) / TOT MA$$

$$OFF-MMH/MA = (TOT OFF-MMH) / TOT MA$$

$$MCS/MA = (MMH/MA) / (EMT/MA)$$

$$TOT MMH = TOT ON-MMH + TOT OFF-MMH$$

C. Spare Parts Requirements

In order to estimate spare parts requirements, it is necessary to distinguish between a failure resulting in a remove and (if a spare is available) replace action versus other maintenance actions such as on-aircraft troubleshoot and repair. Some data sources, such as the LCOM data bases, will provide this additional information. The MODAS system identifies maintenance actions by an action taken code one of which is a removal code. Most sources providing summary level information, however, will not. It may be possible, nevertheless, to estimate the percent of removals by computing the ratio of off-equipment manhours to total manhours since off-equipment work is a result of component removals. Therefore, let

$$RR = \text{removal rate} = (\text{TOT OFF-MMH})/\text{TOT MH}$$

Then the mean number of failures (MFAIL) per mission (sortie) can be estimated from

$$MFAIL = RR \times [1/MFH/MA \times MSN FH \times USE FAC]$$

where MSN FH = Average Mission Length (in flying hours)

and USE FAC = percent of mission time component is operating (may be greater than 100%)

Under the common assumption that the number of failures in a given time period follows a Poisson process, a spare parts level can now be found which will satisfy demands a specified percent of the time.

Let S = spare parts level to support a given mission

and p = desired percent of time demands are satisfied,

then find the smallest value for S such that $F(S) \geq p$
where

$$F(S) = \sum_{i=0}^S \exp(-MFAIL) \times \frac{MFAIL^i}{i!}$$

Finally, if n = number of missions per year, then for a given component,
Total annual maintenance hours = n x MH/FH x MSN FH x USE FAC
and

Total expected annual spares requirement = n x MFAIL.

D. Crew Size Determinations

From the Air Force data sources, crew size information is obtained as a result of individual maintenance task records found in the MODAS system. In order to obtain an average crew size and a crew size distribution, the following calculations are performed.

Let t_{1i} = start time of ith maintenance task

t_{2i} = stop time of ith maintenance task

c_i = assigned crew for ith maintenance task

$P(c)$ = Probability of a crew size of c ,
 $c = 1, 2, \dots, m$

then

$$P(c) = \frac{\sum_{i \in c} (t_{2i} - t_{1i})}{\sum_{all\ i} (t_{2i} - t_{1i})}$$

where the summation in the numerator is over all maintenance task having a crew size of c and the summation in the denominator is taken over all maintenance tasks in the sample. Then the average crew size (ACS) is found by

$$ACS = \sum_c c P(c)$$

Once the average crew size has been determined, an average repair task time can be obtained by

$$EMT/MA = (MMH/MA) / ACS$$

Both the Air Force and Navy R&M reports provide sufficient information to compute most of the R&M parameters using the relationships presented above.

E. Vehicle Level R&M Performance

From the subsystem MTBF's, a vehicle MTBF may be obtained in the following manner.

$$VEH MA/MSN = \sum (1/MFH/MA_i) \times USE FAC_i \times MSN FH$$

$$VEH MFH/MA = MSN FH/(VEH MA/MSN)$$

where MFH/MA_i = mean flying hours between maintenance

action for subsystem i and the summation is taken over all subsystems.

Total vehicle maintenance manhours per mission may be found from

$$VEH MMH = \sum MMH/FH_i \times USE FAC_i \times MSN FH$$

where MMH/FH_i = maintenance manhours per flying hour of the ith subsystem and the summation is taken over all subsystems.

F. Environmental and Technological Adjustments

Previous studies have shown a change in component failure rates as the environment changes from that of the ground and launch phases to the somewhat more benign space environment. Two approaches have been identified to quantify this change. The first is to include an environmental factor in the regression model. This will require including historical data on comparable components operating in space. This data may be quite limited and will be explored during Phase II.

An alternate approach is to make use of some earlier research which concluded failure rates in space were decreasing with the Weibull failure distribution providing a reasonable model. If we assume failures during the launch activity are exponential (an assumption often used by the military), we can equate component reliability of the two models at the transition point, t_0 , between launch and obtaining orbit. Therefore

$$R(t_0) = \exp(-t_0/MTBF) = \exp[-(t_0/k)B]$$

where k is the Weibull scale parameter and B is the Weibull shape parameter.

If we can estimate, in general, the shape parameter (which is positive and less than 1 for a decreasing failure rate), then solving for k:

$$k = t_0 (t_0/\text{MTBF})^{-1/B}$$

and the MTBF for the resulting Weibull distribution is

$$\text{MTBF}_w = k\Gamma(1+1/B) \text{ where } \Gamma \text{ is the gamma function}$$

A technology adjustment factor may be derived by including the development year as a variable in the regression model. However, there is the problem of extrapolating beyond the data. One would expect the impact of technology to be monotonic but at a decreasing rate approaching some finite limit asymptotically. This behavior would suggest certain functional forms within the regression model.

V. Prototype Example

A. Data Base

In order to demonstrate the above methodology and to evaluate the resulting parametric equations, five subsystems found on Air Force aircraft were selected. Air Force subsystems were selected because of the immediate availability of Air Force R&M data. Final results will be based upon more extensive data sources.

Table 1 identifies the file subsystems and Table 2 lists the 21 aircraft comprising the test data base. Six independent variables were selected as R&M "drivers." This list will be updated and expanded during phase II. Table 3 defines the six independent variables. The variable year serves as a surrogate for measuring the level of technology. Values for these independent variables were based upon references [7] and [11] and are presented in Table 4.

Dependent variable values reflecting various R&M parameters were based upon data contained in AFALD Pamphlet 800-4, Vol V and VI. AFALDP 800-4 provides MFH/MA and TOT MMH data by aircraft (mission-design-series) and subsystem (2-digit WUC) over a six month period. A BASIC program (Appendix M) was written to combine several 6-month periods into a single sample in order to obtain a more accurate estimate. This program also computed additional reliability measures using the mathematical relationships discussed in section III. The program was executed for each of the 21 aircraft and for each of the 5 subsystems. Table 5 provides examples of the output for the F-15 landing gear system and the C-5A electrical power systems.

B. Regression Analysis

Stepwise linear regression procedures were used to develop each of the parametric equations. A "best fit" was obtained by selecting the simplest mathematical model having a significant F value, a large R-squared value, and a small standard error. Generally, only independent variables which were significant (based upon a t-test) were

included in the final model. One exception was the inclusion of the variable YEAR if it increased the R-square value and decreased the standard error. By adding this variable to the model, a change in technology year would effect (although at times in a minor way) the estimated reliability. Nonlinear transformations of the independent variables were also included in the model if they significantly contributed to the prediction power of the equation. Generally these transformations consisted of squaring, taking logarithms or square roots of the variables.

TABLE I

Prototype Subsystems

<u>WUC</u>	<u>SUBSYSTEM</u>
11XXX	AIRFRAME (STRUCTURAL)
13XXX	LANDING GEAR
42XXX	ELECTRICAL POWER SYSTEMS
45XXX	HYDRAULIC SYSTEMS
47XXX	OXYGEN SYSTEMS

TABLE 2

USAF Aircraft

<u>TACTICAL</u>	<u>BOMBERS</u>	<u>CARGO/TANKERS</u>	<u>COMMAND/CONTROL</u> <u>/TRAINERS</u>
A-7D	B-1B	C-5A	E-3A
A-10A	B-52G	C-9A	E-4B
F-4E	B-52H	KC-10A	T-38
F-4G		C-130E	
F-5E		KC-135A	
F-15		C-141B	
F-16 A/B			
F-16 C/D			
F-111A			

TABLE 3

Prototype Independent Variables

TO-WGT - TAKE-OFF WEIGHT (1000 lbs)

EM-WGT - EMPTY (DRY) WEIGHT (1000 lbs)

CEIL - SERVICE (OPERATING) CEILING (1000 ft)

WING - WING AREA (1000 SQ ft)

LENGTH - VERTICAL LENGTH (ft)

YR - YEAR FIRST PROTOTYPE FLOWN

Table 4

DATA SET LISTING
DETAILED PROBLEM DATA LISTING FOR
NASA - MASTER DATA BASE - MIL AIRCRAFT

ROW LABEL	MTBM	TO-WGT	EMPTY-WGT	CEILING	WG AREA	LENGTH	YR
A-7D	.	42.	19.5	39.	0.375	46.	68.
A-10A	.	50.	21.5	34.7	0.506	53.3	75.
B-1B	.	395.	192.	65.	1.95	147.	85.
B-52G	.	488.	173.	55.	4.	161.	58.
B-52H	.	488.	173.	55.	4.	161.	61.
E-3A	.	335.	170.	33.	2.9	153.	76.
E-4B	.	775.	352.	45.	5.5	231.	69.
C-5A	.	728.	325.	34.	6.2	248.	68.
C-9A	.	108.	57.2	35.8	1.	119.	68.
KC-10A	.	590.	244.	33.4	3.6	182.	80.
C-130E	.	175.	72.9	33.	1.75	98.	61.
KC-135A	.	316.	106.	35.	2.4	134.	56.
C-141B	.	343.	148.	41.6	3.2	168.	79.
F-4E	.	61.8	30.4	58.75	0.53	63.	67.
F-4G	.	61.8	30.4	58.75	0.53	63.	67.
F-5E	.	25.2	9.7	51.8	0.186	48.	72.
F-15	.	68.	28.	60.	0.61	63.	72.
F-16A/B	.	35.	14.	40.	0.3	47.	76.
F-16C/D	.	42.	18.	50.	0.3	49.3	82.
F-111A	.	91.5	47.5	60.	0.525	73.5	67.
T-38	.	12.1	7.6	53.6	0.17	46.	59.

Table 5

OUTPUT RESULTS FOR C-5A

TOT FLYING-HRS	109290
TOT SORTIES	27783
TOT LANDINGS	85413

WUC 11-AIRFRAME

TOTAL MAINTENANCE EVENTS	79877.98
TOTAL MAINTENANCE MANHOURS	433926
TOTAL ON-EQUIP MAINT	375729
TOTAL OFF-EQUIP MAINT	58197
MEAN FLYING HR BTWN MAINT	1.368212
MEAN SORTIES BTWN MAINT	.347818
MEAN LANDINGS BTWN MAINT	1.069294
MAN-HOURS PER FLY-HR	3.970409
MAN-HOURS PER SORTIE	15.6184
MAN-HOURS PER MAINT ACTION	5.432361
ON-EQUIP MAN-HRS/MAINT ACTION	4.703788
OFF-EQUIP MAN-HRS/MAINT ACTION	.7285738

WUC 13-LAND-GEAR

TOTAL MAINTENANCE EVENTS	77016.03
TOTAL MAINTENANCE MANHOURS	452927
TOTAL ON-EQUIP MAINT	349654
TOTAL OFF-EQUIP MAINT	103273
MEAN FLYING HR BTWN MAINT	1.419055
MEAN SORTIES BTWN MAINT	.3607431
MEAN LANDINGS BTWN MAINT	1.109029
MAN-HOURS PER FLY-HR	4.144268
MAN-HOURS PER SORTIE	16.30231
MAN-HOURS PER MAINT ACTION	5.880945
ON-EQUIP MAN-HRS/MAINT ACTION	4.540016
OFF-EQUIP MAN-HRS/MAINT ACTION	1.340929

Since the variables TO-WGT, EM-WGT, LENGTH, and WG-AREA were highly correlated with one another (see Table 6), it was generally undesirable to have more than one in the model at the same time. The multi-colinearity affect may cause the model to behave abnormally. For example, an increase in empty weight may cause reliability to increase. Therefore, if several of these variables were present and the signs in the regression model were in the wrong direction, one or more of the variables would be deleted from the model. Table 7 provides descriptive statistics on the independent variables.

An investigation of the residuals would, on occasion, identify one or more data points as outliers (two or more standard deviations from the mean). At times these outliers were deleted from the data base. This was based upon the strong possibility that the AFALDP 800-4 data was incomplete. This is particularly true for the Vol VI data which contains a warning to this effect. In processing AFM 66-1, the monthly tapes from the bases may not contain all of the failures logged for that month. On the other hand, the monthly flying hours and sorties reported through a different data system is almost always complete. The net result is an overstatement of the MTBF. This was normally the case when outliers were observed.

The derived parametric equations are presented in Table 8. The statistical analyses including the ANOVA table, t-tests on the coefficients, and a standardized residual table may be found in Appendix L. These equations were integrated into a single BASIC program which will compute the R&M parameters of a conceptual space vehicle as a function of its design and performance specifications. Table 9 illustrates the input and output of this program.

C. Probability Distributions

Since AFALDP 800-4 does not provide sufficient data to derive failure time, repair time or crew size probability distributions, the MODAS reports were evaluated for this purpose. These distributions are important in developing, for example, a computer simulation model of the support and operations of the space vehicle.

Using August 1990 data from the B1-B bomber, MODAS provided start and stop maintenance times for each failure record in the system (see Table 10). Using the repair times computed from these values, a Chi-square goodness of fit test was conducted to determine a suitable distribution. Because of the tendency to report times in whole hours (or 30 minute periods), the data had to be aggregated into four intervals. A significant fit was obtained using either the Weibull or lognormal distributions (see Tables 11 and 12). An empirical crew size distribution was obtained from the MODAS

Table 6

NASA - MASTER DATA BASE - MIL AIRCRAFT
CORRELATION(SAMPLE SIZE) MATRIX

	----TO-WGT----	---EMPTY-WGT---	----CEILING----
TO-WGT	1.000(21)	0.988(21)	-0.217(21)
EMPTY-WGT	0.988(21)	1.000(21)	-0.224(21)
CEILING	-0.217(21)	-0.224(21)	1.000(21)
WG AREA	0.976(21)	0.957(21)	-0.283(21)
LENGTH	0.970(21)	0.971(21)	-0.288(21)
YR	-0.012(21)	0.072(21)	-0.013(21)
	----WG AREA---	----LENGTH----	-----YR-----
TO-WGT	0.976(21)	0.970(21)	-0.012(21)
EMPTY-WGT	0.957(21)	0.971(21)	0.072(21)
CEILING	-0.283(21)	-0.288(21)	-0.013(21)
WG AREA	1.000(21)	0.971(21)	-0.106(21)
LENGTH	0.971(21)	1.000(21)	-0.003(21)
YR	-0.106(21)	-0.003(21)	1.000(21)

Table 7

NASA - MASTER DATA BASE - MIL AIRCRAFT
MEANS, VARIANCES, AND OTHER STATISTICS

	TO-WGT	EMPTY-WGT	CEILING	WG AREA
No. of cases selected :	21	21	21	21
Average :	249.0667	106.6524	46.3048	1.9301
Standard deviation :	245.8650	105.8175	11.0554	1.8647
Skewness :	0.8959	1.0683	0.1558	0.9491
Kurtosis :	-0.4155	0.2185	-1.6063	-0.1506
PERCENTILES :				
0th (Minimum) :	12.1000	7.6000	33.0000	0.1700
5th :	13.4100	7.8100	33.0000	0.1716
25th (Lower Quartile) :	46.0000	20.5000	34.8500	0.4405
50th (Median) :	108.0000	57.2000	45.0000	1.0000
75th (Upper Quartile) :	441.5000	173.0000	56.8750	3.4000
95th :	770.3000	349.3000	64.5000	6.1300
100th (Maximum) :	775.0000	352.0000	65.0000	6.2000
	LENGTH	YR		
No. of cases selected :	21	21		
Average :	112.1000	69.8095		
Standard deviation :	64.1190	8.1155		
Skewness :	0.6456	0.0818		
Kurtosis :	-0.6684	-0.7263		
PERCENTILES :				
0th (Minimum) :	46.0000	56.0000		
5th :	46.0000	56.2000		
25th (Lower Quartile) :	51.3000	64.0000		
50th (Median) :	98.0000	68.0000		
75th (Upper Quartile) :	161.0000	76.0000		
95th :	246.3000	84.7000		
100th (Maximum) :	248.0000	85.0000		

TABLE 8-1

PARAMETRIC EQUATIONS
MEAN FLYING HRS/MAINTENANCE ACTION

WUC

11XXX:

AIRFRAME MFH/MA = $23.22925 - 0.111771 \text{ CEIL} + 12.6007 \text{ WING}$
 - $0.0576 \text{ LENGTH} - 0.005075 \text{ YR}$
 - $21.97399 \text{ SQR WING} - 0.684188 \text{ WING}^2$

13XXX:

LANDING GEAR MFH/MA = $23.86407 - 1.409666 \text{ SQR LENGTH}$

42XXX:

ELEC PWR SYS MFH/MA = $- 271.444 - 0.212449 \text{ TO-WGT}$
 + $0.533079 \text{ CEIL} - 0.768166 \text{ YR}$
 + $28.35901 \text{ SQR LENGTH}$
 + $7697.175 \text{ 1/LENGTH}$

45XXX:

HYDRAULICS MFH/MA = $49.40489 + 0.369793 \text{ TO-WGT}$
 - $0.49955 \text{ EM-WGT} + 39.86846 \text{ WING}$
 - $0.620174 \text{ LENGTH} + 1.240129 \text{ YR}$
 + $22.75922 \text{ MISSION} - 157.5092 \text{ SQR WING}$

47XXX:

OXYGEN SYS MFH/MA = $260.1071 + 0.213175 \text{ TO-WGT}$
 + $18.61948 \text{ MISSION} - 61.79837 \text{ SQR WING}$
 - $19.19873 \text{ SQR LENGTH}$

TABLE 8-2

PARAMETRIC EQUATIONS
MAINTENANCE MAN-HRS/FLYING HR

WUC

11XXX:

AIRFRAME MMH/FH = - 4.953856 - 0.01547 TO-WGT
+ 0.051091 CEIL - 2.934957 WING
+ 0.33163 SQR TO-WGT + 5.518674 SQR WING
+ 0.357075 WING²

13XXX:

LANDING GEAR MMH/FH = - 53.66402 + 17.08925 LOG YR
- 0.267969 YR + 0.094115 SQR LENGTH

42XXX:

ELEC PWR SYS MMH/MA = 11.30551 + 0.001867 EM-WGT
+ 0.263477 CEIL - 3.450736 SQR CEIL

45XXX:

HYDRAULICS MMH/MA = 0.926234 + 0.010833 CEIL - 0.586775 WING
+ 0.014184 LENGTH - 0.008041 YR
- 0.051832 MISSION + 1.779134 SQR WING
- 0.306858 SQR LENGTH

47XXX:

OXYGEN SYS MMH/FM = 0.452033 - 0.011884 MISSION
- 4.298343 1/LENGTH - 0.036333 SQR YR

Table 9-1

R&M Analysis Program - Input

WELCOME TO THE NASA SPACE VEHICLE R&M ANALYSIS PROGRAM

ENTER PROJECT TITLE? EXAMPLE
 ENTER VEHICLE NAME? ADVANCED SPACE VEHICLE

OPERATIONAL/SUPPORT PARAMETERS

ENTER TYPICAL MISSION TIME IN HOURS? 48
 ENTER MISSION HOURS FOR LAUNCH AND ORBIT INSERTION? 5
 ENTER MISSIONS PER YEAR? 20
 ENTER MAX ORBIT IN MILES? 200
 ENTER YEAR OF FIRST FLIGHT - E.G. 93? 94
 ENTER SPARES SUPPORT AS A FRACTION OF FILLED DEMANDS? .9

DESIGN PARAMETERS

ENTER VEHICLE EMPTY WEIGHT IN 1000 POUNDS? 1100
 ENTER VEHICLE LENGTH IN FEET? 90
 ENTER MAX VEHICLE TAKE-OFF WEIGHT IN 1000 POUNDS? 130
 ENTER WING AREA IN 1000'S SQ FT? 1.5

SUBSYSTEM	USE FACTOR	
WUC11-AIRFRAME	1	1
WUC13-LANDING GEAR	1	2
WUC42-ELECTRICAL	1.2	3
WUC45-HYDRAULIC	1	4
WUC47-OXYGEN SYS	1.1	5

DO YOU WISH TO CHANGE A USE FACTOR-Y/N??

SUBSYSTEM	REMOVAL RATE	
WUC11-AIRFRAME	.2	1
WUC13-LANDING GEAR	.6	2
WUC42-ELECTRICAL	.7	3
WUC45-HYDRAULIC	.8	4
WUC47-OXYGEN SYS	.3	5

Table 9-2

R&M Analysis Program - Output

PROJECT EXAMPLE

VEHICLE ADVANCED SPACE VEHICLE

DATE:10-06-1991

INPUT PARAMETERS

MISSION TIME	72	HOURS
MISSIONS PER YR	20	
MAX ORBIT	200	MILES
FIRST FLIGHT	90	
EMPTY WEIGHT	100	1000 POUNDS
MAX TAKE-OFF WGT	130	1000 POUNDS
WING AREA	1.5	1000 SQ FEET
VEHICLE LENGTH	90	FEET

SUBSYSTEM R&M PARAMETERS

WUC	SYSTEM	MPHMA	MHFH	MANHRS/MSN
11***	AIRFRAME	4.237383	1.713253	123.3542
13***	LANDING GEAR	10.49081	9.991109E-03	.7193599
42***	ELECTRICAL SYS	4.488701	.3293533	23.71344
45***	HYDRAULICS SYS	38.49068	7.964253E-02	5.734263
47***	OXYGEN SYS	85.85588	2.393657E-02	1.723433

SUBSYSTEM MPHMA ADJUSTED FOR SPACE

WUC	SYSTEM	ADJ MPHMA
11***	AIRFRAME	4.473464
13***	LANDING GEAR	12.99671
42***	ELECTRICAL SYS	4.787213
45***	HYDRAULICS SYS	59.97994
47***	OXYGEN SYS	154.1365

VEHICLE R&M PARAMETERS- ADVANCED SPACE VEHICLE

TOTAL MANHOURS PER MISSION	160.1597
TOTAL MAINTENANCE ACTIONS	45.89617
MEAN MSN HOURS BTWN MAINT	1.568759
ANNUAL MAINTENANCE ACTIONS	917.9232
ANNUAL MAINTENANCE MANHRS	3203.195

RESULTS OF SPARES CALCULATIONS

SUBSYSTEMS	MEAN DEMAND	STOCK LVL
WUC11-AIRFRAME	3.398324	6
WUC13-LANDING GEAR	4.117891	7
WUC42-ELECTRICAL	13.47383	18
WUC45-HYDRAULIC	1.496466	3
WUC47-OXYGEN SYS	.2767429	1

STOCK LEVEL BASED UPON A .9 FILL RATE

Table 10

*** M O D A S II ***

Record Type: A
MDS: B001B

Detail Maintenance Data Report

THU, SEP 19 1991
14:41:09

Year	Day	Time	Start	Stop	WUC	Type	Fail	How	Mal	When	Disco	Action
1	170	00000	0900	1000	42BA0	6		799		2		H
1	170	00000	1100	1200	42BA0	6		799		D		H
1	170	00000	0700	0730	42BLZ	2		105		F		G
1	171	00000	0205	0305	42BA0	6		799		E		X
1	171	00994	1400	1500	42BAC	6		800		F		S
1	171	00994	1400	1500	42BAC	6		800		F		S
1	171	00000	2000	2100	42BAD	1		169		F		R
1	171	01582	0100	0330	42BAH	1		718		B		R
1	171	00000	2330	0130	42BAH	2		105		F		G
1	171	00000	0005	0205	42BEO	6		799		E		X
1	171	00000	0905	1000	42BEA	6		799		F		T
1	171	00000	0630	0800	42BEA	6		799		F		U
1	171	00000	0805	0900	42BEA	6		799		F		U
1	172	01396	0900	0905	42BAA	1		615		F		R
1	175	00000	1400	1500	42BA0	2		105		M		G
1	175	00000	0900	1000	42BAH	2		105		F		G
1	175	00000	0900	1000	42BAH	2		105		F		G
1	176	00000	1100	1200	42BA0	2		105		M		G
1	176	00000	1330	1400	42BA0	2		105		M		G
1	176	00000	1400	1500	42BA0	2		105		M		G
1	178	00000	1200	1300	42BA0	6		799		F		X
1	178	00000	0440	0500	42BAB	6		799		F		X

Repair Time Observations

ORDERED ARRAY OF OBSERVATIONS

5	5	5	5	5
5	5	10	10	15
20	20	20	20	20
25	25	30	30	30
30	30	30	30	30
30	30	30	30	30
30	30	30	30	30
30	30	30	30	30
30	30	30	30	30
40	55	60	60	60
60	60	60	60	60
60	80	60	60	60
60	80	60	60	60
60	80	80	60	60
60	60	60	60	60
80	80	80	60	60
60	60	60	60	60
60	60	60	60	60
60	60	60	60	60
90	90	90	90	90
90	90	90	115	115
115	120	120	120	120
120	120	120	120	120
120	120	120	120	120
120	120	120	120	120
120	120	120	120	120
120	120	120	120	150
150	150	150	175	175
180	180	180	180	180
180	180	180	180	240
240	240	240	240	240
240	240	240	240	240
240	240	270	270	285
300	300	300	300	300
300	330	360	395	420
420	450	450	480	480

SAMPLE SIZE	185	
MEAN	113.2432	
APPROX 90% CONF INTERVAL	100.8087	125.6778
MEDIAN	80	
VARIANCE	10570.67	
STANDARD DEVIATION	102.8138	
VARIANCE/MEAN RATIO	93.34486	
COEFFICIENT OF VARIATION	.9078022	
RANGE	475	
SKEWNESS-(B1)	1.808345	
10% CRITICAL VALUES FOR B1=0	-.2962482	.2962482
KURTOSIS-(B2)	5.298713	
10% CRIT VALUES FOR B2=3 (NORMAL)	2.407804	3.592497

Table 12

Goodness-of-Fit Tests

Repair Time Distributions

CHI-SQUARE COMPUTATION

WEIBULL WITH SCALE PARAMETER= 120 AND SHAPE PARAMETER= 1.17

CELL	LOWER	UPPER	OBS	EXP	(O-E) ² /E
1.00	0.00	41.37	46.00	46.25	0.00
2.00	41.37	87.73	51.00	46.25	0.49
3.00	87.73	158.84	46.00	46.25	0.00
4.00	158.84	9999.00	42.00	46.25	0.39

CHI-SQUARE STATISTIC= .8810811 DEGREES OF FREEDOM= 1
 95% CRITICAL VALUE= 3.84 90% CRITICAL VALUE= 2.71
 CANNOT REJECT AT 10% LEVEL

MEAN OF LOGNORMAL= 121.8989 WITH STND DEV= .9832414

CELL	LOWER	UPPER	OBS	EXP	(O-E) ² /E
1.00	-9999.00	3.66	46.00	46.25	0.03
2.00	3.66	4.32	52.00	46.25	0.71
3.00	4.32	4.98	42.00	46.25	0.39
4.00	4.98	9999.00	46.00	46.25	0.00

CHI-SQUARE STATISTIC= 1.140541 DEGREES OF FREEDOM= 1
 95% CRITICAL VALUE= 3.84 90% CRITICAL VALUE= 2.71
 CANNOT REJECT AT 10% LEVEL

Detail Maintenance Data report which identifies again the start and stop time of each maintenance activity along with the assigned crew size. Using the procedures discussed in Section III, the crew size distribution and average (mean) crew size were found (Table 13). Since this distribution was based on over 130 individual maintenance tasks, it is assumed to be representative of the crew size requirements for this particular component (AC power system) on B-1B.

An attempt to derive a failure time distribution from the MODAS data was more difficult. MODAS provides the julian date and time (although time does not appear to be very accurate) of each failure. However flying hours (and sorties) are reported monthly. Therefore it is impossible to determine from this data set the actual flying hours between failures. However, it may be possible to show in some cases that the number of failures per flying hour is Poisson by taking failures per month and converting to failures per flying hour. Therefore the time (flying hours) between failures would be exponential. This approach is currently being pursued.

VI. Conclusions and Phase II Research

From the above analysis and examples, useful data sources exist and meaningful parametric equations can be derived for major subsystems. The estimated R&M parameters can be utilized to provide overall vehicle reliability and maintainability parameters. Repair time and crew size distributions can also be obtained, however, failure time distributions will require further analysis.

The Phase II effort will:

1. Continue to expand upon the data sources,
2. Derive parametric equations for all major aircraft subsystems,
3. Develop parametric equations at the component level,
4. Explore failure time distributions,
5. Include booster rockets,
6. Develop costing procedures including spare parts determinations,
7. Further develop environmental (space) and technological factors for use in adjusting the R&M parameters.

Table 13

Crew Size Probability Distributions

Record Type: A
MDS: B001B

*** M O D A S II ***
Detail Maintenance Data Report

Page: 1
TUE. SEP 24 1991
10:29:05

JCN (Julian Day)	JCN2 (Serial)	Day (Julian)	Year (1 digit)	Time	WUC	Type Maint	Action Taken	When Disco	How Mal	Failure (1,2 or 6)	Start Time	Stop Time	Crew Size	Tail No.	Base Id	Cmd
208	0262	211	0	00000	42BD0	C	X	F	002	6	1030	1630	2	6110	JFSD	09
211	0120	211	0	00541	42BDA	B	R	F	721	1	0700	1300	3	6115	JFSD	05
211	4151	211	0	00688	42BDA	B	T	D	799	6	1500	1530	3	6118	JFSD	05
221	0230	221	0	00000	42B99	B	E	F	127	1	1420	1440	3	6119	JFSD	05
221	0230	221	0	00000	42BA0	B	X	F	799	6	1440	1500	3	6115	JFSD	05
221	0230	221	0	00000	42BA0	B	Y	F	242	1	1400	1420	3	6115	JFSD	05
223	0357	223	0	00000	42BA0	B	H	C	799	6	0800	1600	2	5064	FNWZ	05
224	3258	223	0	00000	42BD0	B	G	D	105	2	0700	1000	2	5080	PRQE	05
225	0038	225	0	00000	42BD0	B	B	F	281	1	1730	1930	2	6115	JFSD	05
225	4151	225	0	00000	42BAA	B	T	F	799	6	1400	1500	2	6129	PRQE	05
225	4151	225	0	00000	42BAA	B	J	F	799	6	1500	1600	2	6129	PRQE	05
225	0314	225	0	00000	42BD0	B	G	E	105	2	1930	2000	2	5070	FNWZ	05
225	4052	225	0	00601	42BAC	B	G	F	450	1	1300	1600	3	6139	PRQE	05
225	5553	226	0	00000	42BA0	B	X	D	799	6	0700	0800	2	6093	FXBM	05
227	0199	226	0	00000	42BA0	B	Y	E	799	6	1100	1200	2	6126	PRQE	05
227	0326	226	0	00000	42BA0	B	X	F	799	6	0700	0900	2	6126	PRQE	05
227	5553	226	0	00927	42BAA	B	R	D	255	1	0000	0200	2	6093	FXBM	05
227	0559	227	0	00000	42BA0	B	H	F	799	6	0800	0900	2	3070	FNWZ	05
227	0251	227	0	00000	42BA0	B	X	E	799	6	0700	0900	2	5062	FNWZ	05
208	0031	227	0	00000	42BA0	B	X	F	799	6	2130	2400	3	6118	JFSD	05
227	0299	227	0	00000	42BAA	B	R	B	721	1	1200	1300	2	4058	FNWZ	05
207	0148	227	0	00000	42BE0	B	X	E	799	6	0800	0000	0	6113	JFSD	05

PROBABILITY DISTRIBUTION FOR CREW SIZE

AIRCRAFT IS B-1B
WORK UNIT CODE IS 42B**
NOMENCLATURE IS AC POWER SYSTEM

CREW SIZE	PROB	CUM PROB
1.00	0.11	0.11
2.00	0.52	0.63
3.00	0.33	0.96
4.00	0.03	0.99
5.00	0.01	0.99
6.00	0.01	1.00
7.00	0.00	1.00
8.00	0.00	1.00

AVERAGE CREW SIZE IS 2.326485

BIBLIOGRAPHY

1. *Aircraft Historical Reliability and Maintainability Data*, Vols. V & VI, J. Osmanski, ed. Air Force Acquisition Logistics Center, Pamphlet 800-4. Dayton: Department of the Air Force, 1988, 1990.
2. *Aviation 3-M Information Reports*, NAVSEALOGCEN INSTR 4790.1. Mechanicsburg: Department of the Navy, 1988.
3. Barnard, R. A. and T. D. Matteson. "Military Aircraft Maintenance - A New Concept." *Proceedings 1975 Annual Reliability and Maintainability Symposium* pp. 596-600. New York: Institute of Electrical and Electronic Engineers, 1975.
4. Bloomquist, C. and W. Graham. *Analysis of Spacecraft On-orbit Anomalies and Lifetimes*. For Goddard Space Flight Center Contract No. NAS 5-27279. Los Angeles: PRC Systems Service, 1983.
5. Brussell, E. R., K. R. Pope, and K. M. Tasugi. "Cost of Ownership - Industry Viewpoint: Parametric Analysis of Operating and Support Costs." *Proceedings 1975 Annual Reliability and Maintainability Symposium* pp. 217-220. New York: Institute of Electrical and Electronic Engineers, 1975.
6. Earles, D. R. "LCC - Commercial Application: Ten Years of Life Cycle Costing." *Proceedings 1975 Annual Reliability and Maintainability Symposium* pp. 74-85. New York: Institute of Electrical and Electronic Engineers, 1975.
7. Green, W. and G. Swanborough. *Observer's Directory of Military Aircraft*. New York: Arco Publishing, Inc., 1982.
8. Harmon, D. F., P. A. Pates, and D. Gregor. "Maintainability Estimating Relationships." *Proceedings 1975 Annual Reliability and Maintainability Symposium* pp. 18-25. New York: Institute of Electrical and Electronic Engineers, 1975.
9. Hecht, H. and E. Florentino. "Reliability Assessment of Spacecraft Electronics." *1987 Proceedings Annual Reliability and Maintainability Symposium* pp. 341-345. New York: Institute of Electrical and Electronic Engineers, 1987.
10. Hecht, H. and M. Hecht. *Reliability Prediction for Spacecraft*. Rome Air Development Center Final Technical Report No. 85-229, 1985.
11. *Jane's All the World's Aircraft*, J. W. R. Taylor, ed. New York: McGraw-Hill Book Company, 1971-1990.

12. Kern, G. A. and T. M. Drnas. *Operational Influences on Reliability*. For Rome Air Development Center Contract No. RADC-TR-76-366. Culver City: Hughes Aircraft Company, 1975.
13. Norris, H. P. and A. R. Timmins. "Failure Rate Analysis of Goddard Space Flight Center: Spacecraft Performance During Orbital Life." *Proceedings 1976 Annual Reliability and Maintainability Symposium* pp. 120-125. New York: Institute of Electrical and Electronic Engineers, 1976.
14. Ostrofsy, B. "Development of I.L.S. Models from R and M Data." *Proceedings 1975 Annual Reliability and Maintainability Symposium* pp. 130-138. New York: Institute of Electrical and Electronic Engineers, 1975.
15. Peacore, E. J. "Reliability Developments - AWACS." *Proceedings 1975 Annual Reliability and Maintainability Symposium* pp. 383-389. New York: Institute of Electrical and Electronic Engineers, 1975.
16. *Personnel Launch System Advanced Manned Launch System (AMLS): PLS Reliability/Maintainability Analysis*, Ehrlich, Jr., C. F., ed. For Langley Research Center Contract No. NAS1-18975. Los Angeles: Rockwell International Space Systems Division, 1990.
17. *Personnel Launch System (PLS) Advanced Manned Launch System Study (PLS/AMLS): Final Oral Review*. For Langley Research Center Contract No. NAS1-18975. Los Angeles: Rockwell International Space Systems Division, 1990.
18. *Report on the Development of a Spacecraft Supportability Assessment Model*. For Langley Research Center. Los Angeles: Rockwell International Space Systems Division, n.d.

APPENDIX A
AFALD PAMPHLET 800-4

AIRCRAFT SYSTEM RELIABILITY AND MAINTAINABILITY SUMMARY

AIRCRAFT COO9A REPORT PERIOD: 1 APR 86 TO 30 SEP 86

AVG. INVENTORY: 17 FLYING HOURS: 13126 SORTIES: 10726 LANDINGS: 14402

WUC SYS	SYSTEM NOUN	MEAN-TIME-BETWEEN-MAINTENANCE				NUMBER OF MAINTENANCE MAN-HOURS				TOTAL			
		INHERENT	INDUCED	NO DEFECT	TOTAL	ON EQ	OFF EQ	ON EQ	OFF EQ	ON EQ	OFF EQ	ON EQ	OFF EQ
03	*SCHED INSP L/J/K PH	.00	.00	.00	.000	0	0	0	0	0	0	9965	0
04	*SPECIAL INSP	.00	.00	.00	.000	0	0	0	0	0	0	2464	11
11	AIRFRAME	20.70	20.01	97.96	9.141	3946	266	1485	1878	997	14	6457	630
12	COCKPIT & FUS COMPT	27.29	12.66	75.01	7.618	1509	519	1878	139	797	56	4359	1889
13	LANDING GEAR SYS	21.14	64.03	93.09	13.518	3092	252	380	545	752	1249	4244	2132
14	FLIGHT CONTROLS	33.15	83.08	66.29	17.408	2745	76	807	2	1124	8	4474	224
23	TURBO FAN PWR PLANT	56.09	68.01	89.28	22.788	2121	100	804	28	1416	36	4360	441
24	AUXILIARY PWR PLANT	135.32	437.53	267.88	73.742	742	1	57	12	278	0	1094	24
41	AIR COND. PRESBICE	60.49	111.24	89.29	27.232	1196	10	342	13	742	0	2280	65
42	ELECTL PWR SUPPLY	177.38	656.30	375.03	100.969	2534	362	81	0	194	0	2815	394
44	LIGHTING SYSTEM	28.17	112.19	336.56	20.868	973	5	169	2	132	0	1315	34
45	HYD & PNEU PR SUPPLY	149.16	345.42	257.37	74.158	456	7	64	0	223	0	743	7
46	FUEL SYSTEM	128.69	570.70	172.71	64.980	1610	0	108	0	830	0	2578	2
47	OXYGEN	218.77	328.15	164.08	71.727	271	13	114	3	410	0	804	26
49	MISC UTILITIES	525.04	656.30	937.57	218.767	181	0	77	0	79	0	345	18
51	INSTRUMENTS	190.23	820.38	120.42	67.313	282	13	29	0	374	14	686	52
52	AUTOPILOT	144.24	2187.67	226.31	84.684	391	0	2025	0	285	0	2701	10
56	ALL WEATHER LND SYS	99.44	937.57	119.33	51.074	537	0	43	0	438	0	1021	6
61	HF COMMUNICATIONS	729.22	.00	4375.33	596.636	68	4	0	0	5	0	79	10
62	VHF COMMUNICATIONS	201.94	.00	1875.14	179.808	212	10	0	0	17	0	236	10
63	UHF COMMUNICATIONS	201.94	13126.00	2625.20	184.873	200	0	1	0	16	0	217	0
64	INTERPHONE 6810 11	114.14	1458.44	1458.44	98.692	336	7	10	0	41	0	386	37
65	IFF/ATC APX 64	820.38	.00	423.42	278.277	62	0	0	0	46	0	108	0
66	EMERGENCY COMMUN	1193.27	13126.00	437.53	312.524	91	4	4	0	103	14	198	28
69	MISC COMM EQUIP	437.53	4375.33	6583.00	375.029	58	0	2	0	28	0	88	0
71	*RADIO NAVIGATION	125.01	1458.44	729.22	99.439	507	83	22	4	74	13	603	179
72	RADAR NAVIGATION	195.91	4375.33	504.85	136.729	354	221	29	0	97	0	479	221
91	EMERGENCY EQUIP	1312.60	4375.33	1875.14	656.300	15	0	20	0	11	44	46	44
97	*EXP DEV & COMP	.00	13126.00	.00	13126.000	0	0	1	0	0	0	1	0

TOTAL SYSTEMS

3.06 4.82 7.72 1.495 24489 1953 8252 787 9511 1448 55149 6285

APPENDIX B

MODAS

System Summary - Reliability

Date Range = July, 1991 TO July, 1991

, Base Code = ****

MDS/WUC = F015A /*****

System	Removal	MTBR	Failure Count				MTBM			
			T1	T2	T6	Total	T1	T2	T6	Total
2 =POWER PLAN	865	7	682	45	1317	2044	9	141	4	3
03=LOOK PH SC	0	0	0	0	0	0	0	0	0	0
04=SPECIAL IN	0	0	0	0	0	0	0	0	0	0
11=AIRFRAME	37	171	215	20	247	482	29	317	25	13
12=CKPT & FUS	46	137	43	3	96	142	147	2114	66	44
13=LANDING GE	302	21	306	17	119	442	20	373	53	14
14=FLIGHT CON	81	78	118	10	120	248	53	634	52	25
32=NOT DEFINE	0	0	0	0	8	8	0	0	792	792
41=AIR COND P	38	166	53	3	99	155	119	2114	64	40
42=ELECTRICAL	36	176	30	1	60	91	211	6343	105	69
43=NOT DEFINE	0	0	0	0	5	5	0	0	1268	1268
44=LIGHTING S	31	204	38	1	25	64	166	6343	253	99
45=HYD AN PNE	66	96	88	1	73	162	72	6343	86	39
46=FUEL SYSTE	85	74	77	3	147	227	82	2114	43	27
47=OXYGEN SYS	13	487	14	1	9	24	453	6343	704	264
49=MISC UTILI	19	333	11	1	36	48	576	6343	176	132
51=INSTRUMENT	149	42	150	3	162	315	42	2114	39	20
52=AUTOPILOT	39	162	39	0	59	98	162	0	107	64
53=NOT DEFINE	0	0	0	0	1	1	0	0	6343	6343
54=NOT DEFINE	1	6343	1	0	0	1	6343	0	0	6343
55=MALF ANAL	17	373	19	0	12	31	333	0	528	204
57=INTER GUID	18	352	66	4	31	101	96	1585	204	62
62=NOT DEFINE	0	0	1	0	0	1	6343	0	0	6343
63=UHF COMMUN	89	71	169	5	90	264	37	1268	70	24
65=IFF	89	71	174	8	91	273	36	792	69	23
71=RADIO NAVI	112	56	113	1	120	234	56	6343	52	27
74=FIRE CONTR	415	15	447	5	560	1012	14	1268	11	6
75=WPN DLVRY	91	69	90	2	373	465	70	3171	17	13
76=TAC ELEC W	116	54	163	0	116	279	38	0	54	22
91=EMERG EQUI	19	333	1	0	20	21	6343	0	317	302
92=TOW TARGET	0	0	0	0	0	0	0	0	0	0
97=EXPLOSIVE	123	51	3	1	124	128	2114	6343	51	49
TOTAL	2897		3111	135	4120	7366				

System Summary - Maintainability

Date Range = August, 1989 TO July, 1991

, Base Code = ****

MDS/WUC = F015B /**** F015A /****

System	Maintenance Manhours				On Equip.		Off Equip.	
	On-eq	Off-eq	Supp	Total	MH/FH	MMHTR	MHTR	MHTC
01=NOT DEFINE	0	0	549874	549874	3.464	0.000	0	0
2 =POWER PLAN	599911	289764	173219	1062894	6.697	9.334	40376	0
03=LOOK PH SC	0	0	721345	721345	4.545	0.000	0	0
04=SPECIAL IN	0	0	544554	544554	3.431	0.000	0	0
05=NOT DEFINE	0	0	447	447	0.003	0.000	0	0
06=NOT DEFINE	0	0	77327	77327	0.487	0.000	0	0
07=NOT DEFINE	0	0	44412	44412	0.280	0.000	0	0
08=NOT DEFINE	0	0	1034	1034	0.007	0.000	0	0
09=NOT DEFINE	0	4	195225	195229	1.230	0.000	0	0
10=NOT DEFINE	6	0	0	6	0.000	0.600	0	0
11=AIRFRAME	268809	6427	0	275236	1.734	3.846	3617	0
12=CKPT & FUS	50057	4522	0	54579	0.344	5.778	3389	4
13=LANDING GE	70593	41831	0	112424	0.708	5.094	19236	0
14=FLIGHT CON	81141	9679	0	90820	0.572	6.670	5387	1
15=NOT DEFINE	53	22	0	75	0.000	4.417	11	0
16=NOT DEFINE	25	60	0	85	0.001	1.333	60	0
17=NOT DEFINE	9	21	0	30	0.000	2.250	0	0
18=NOT DEFINE	6	0	0	6	0.000	2.000	0	0
31=NOT DEFINE	76	0	0	76	0.000	3.455	0	0
32=NOT DEFINE	192	2	0	194	0.001	3.176	0	0
33=NOT DEFINE	33	4	0	37	0.000	5.200	0	0
34=NOT DEFINE	33	18	0	51	0.000	4.833	8	0
36=NOT DEFINE	5	0	0	5	0.000	5.000	0	0
39=NOT DEFINE	21	0	0	21	0.000	2.000	0	0
40=NOT DEFINE	3	0	0	3	0.000	0.000	0	0
41=AIR COND P	46537	8391	0	54928	0.346	5.945	6787	0
42=ELECTRICAL	31397	25912	0	57309	0.361	6.465	22499	0
43=NOT DEFINE	335	1	0	336	0.002	2.629	0	0
44=LIGHTING S	33792	5519	0	39311	0.248	3.126	4080	0
45=HYD AN PNE	53546	5627	0	59173	0.373	5.961	3510	0
46=FUEL SYSTE	138550	7347	0	145897	0.919	13.417	1660	0
47=OXYGEN SYS	6246	1316	0	7562	0.048	3.739	528	0
48=NOT DEFINE	1033	0	0	1033	0.007	13.800	0	0
49=MISC UTILI	13409	790	0	14199	0.089	8.214	317	0
50=NOT DEFINE	528	0	0	528	0.003	1.000	0	0
51=INSTRUMENT	43838	14741	0	58579	0.369	4.678	4711	0
52=AUTOPILOT	19660	11820	0	31480	0.198	7.998	7613	0
53=NOT DEFINE	4334	22	0	4356	0.027	6.414	7	0
54=NOT DEFINE	152	1	0	153	0.001	5.500	0	0
55=MALE ANAL	7908	5097	0	13005	0.082	4.224	2858	0
56=NOT DEFINE	2	0	0	2	0.000	0.000	0	0
57=INTER GUID	8441	5091	0	13532	0.085	3.471	3147	0
59=NOT DEFINE	1	0	0	1	0.000	1.000	0	0
61=NOT DEFINE	2	16	0	18	0.000	0.000	13	0
62=NOT DEFINE	6	19	0	25	0.000	2.000	12	0
63=UHF COMMUN	29126	25204	0	54330	0.342	3.316	16979	1
64=NOT DEFINE	77	43	0	120	0.001	4.714	41	0
65=IFF	26519	40602	0	67121	0.423	3.140	32205	0
66=NOT DEFINE	13	33	0	46	0.000	2.000	27	0
69=NOT DEFINE	11	0	0	11	0.000	0.000	0	0
70=NOT DEFINE	1	0	0	1	0.000	1.000	0	0
71=RADIO NAVI	34342	28190	0	62532	0.394	4.096	13382	0

Failures selected are All Failures

Reliability - MTBM (by type)

Date Range = August, 1989 TO July, 1991 , Base Code = ****

MDS/WUC = F015A /74F** F015B /74F**

Flight Hours			Mean Time Between Maint.		
Date	Mo	Cum	Failure Count	Monthly	3mo avg Cum
8 89	7782	7782	949	8.20	8.20 8.20
9 89	5327	13109	615	8.66	8.38 8.38
10 89	7402	20511	845	8.76	8.51 8.51
11 89	6066	26577	750	8.09	8.50 8.41
12 89	5394	31971	589	9.16	8.64 8.53
1 90	6587	38558	1112	5.92	7.36 7.93
2 90	6100	44658	625	9.76	7.77 8.14
3 90	7133	51791	919	7.76	7.46 8.09
4 90	7369	59160	553	13.33	9.82 8.50
5 90	6908	66068	897	7.70	9.04 8.41
6 90	6861	72929	794	8.64	9.42 8.43
7 90	5732	78661	1163	4.93	6.83 8.02
8 90	7428	86089	741	10.02	7.42 8.16
9 90	5127	91216	961	5.34	6.38 7.92
10 90	7004	98220	1092	6.41	7.00 7.79
11 90	6821	105041	703	9.70	6.88 7.89
12 90	5449	110490	726	7.51	7.65 7.87
1 91	6182	116672	955	6.47	7.74 7.78
2 91	6135	122807	792	7.75	7.18 7.78
3 91	7043	129850	830	8.49	7.51 7.82
4 91	6757	136607	936	7.22	7.79 7.79
5 91	7768	144375	916	8.48	8.04 7.82
6 91	6895	151270	691	9.98	8.42 7.90
7 91	7449	158719	707	10.54	9.56 7.99
TOTAL	158719		19861		

JCN (Julian Day)	JCN2 (Serial)	Day (Julian)	Year (1 digit)	Time WUC	Type Maint	Action Taken	When Disco	How Mal	Failure Mal (1,2 or 6)	Start Time	Stop Time	Crew Size	Tail No.	Base Id	Cmd
208	0262	211	0	00000	42B00	C	F	002 6		1030	1630	2	6110	JFSD	08
211	0120	211	0	00541	42BDA	B	F	721 1		0700	1330	3	6115	JFSD	08
211	4151	211	0	00688	42BDA	B	D	799 6		1500	1530	3	6118	JFSD	08
221	0230	221	0	00000	42B99	B	F	127 1		1420	1440	3	6115	JFSD	08
221	0230	221	0	00000	42BA0	B	F	799 6		1440	1500	3	6115	JFSD	08
221	0230	221	0	00000	42BA0	B	F	242 1		1400	1420	3	6115	JFSD	08
221	0357	222	0	00000	42BA0	B	C	799 6		0800	1600	2	5069	FNNW	05
221	0258	223	0	00000	42B00	B	2	105 2		0700	1000	2	5080	PRQE	08
223	0038	223	0	00000	42BDB	B	F	381 1		1730	1930	2	6115	JFSD	08
225	4151	225	0	00000	42BAA	B	F	799 6		1400	1500	2	6129	PRQE	08
225	4151	225	0	00000	42BAA	B	F	799 6		1500	1600	2	6129	PRQE	08
225	0314	225	0	00000	42B00	B	E	105 2		1930	2000	2	5070	FNNW	08
225	4052	225	0	00601	42BAC	B	F	450 1		1300	1600	3	6139	PRQE	08
225	5553	226	0	00000	42BA0	B	D	799 6		0700	0800	2	6093	FXBM	08
157	0199	226	0	00000	42BA0	B	B	799 6		1100	1200	2	6126	PRQE	08
204	0326	226	0	00000	42BA0	B	F	799 6		0700	0900	2	6126	PRQE	08
225	5553	226	0	00927	42BAA	B	D	255 1		0005	0200	2	6093	FXBM	08
227	0559	227	0	00000	42BA0	B	F	799 6		0800	0900	2	5062	FNNW	08
227	0251	227	0	00000	42BA0	B	B	799 6		0700	0900	2	6118	JFSD	08
208	0031	227	0	00000	42BA0	B	F	799 6		2130	2400	3	6118	JFSD	08
227	0299	227	0	00000	42BAA	B	B	721 1		1200	1300	2	4058	FNNW	08
207	0148	227	0	00000	42BE0	B	B	799 6		0000	0000	0	6113	JFSD	08
211	4151	227	0	00688	42BDA	B	D	799 6		0200	0400	1	6118	JFSD	08
227	4152	227	0	00874	42BDA	B	F	799 6		0005	0200	1	6113	JFSD	08
227	0251	228	0	00000	42BA0	B	B	799 6		1400	1600	2	5062	FNNW	08
208	0031	228	0	00000	42BA0	B	F	799 6		0005	0045	3	6118	JFSD	08
227	0109	228	0	00000	42BAH	B	F	799 6		0700	0800	1	6130	PRQE	08
228	4519	228	0	00000	42BDA	B	F	799 6		1730	1900	5	3071	FNNW	08
228	0436	228	0	00000	42BDA	B	F	615 1		2200	2330	6	5071	FNNW	08
229	0222	229	0	00000	42BA0	B	D	799 6		2230	2300	3	6118	JFSD	08
229	0222	229	0	00000	42BA0	B	D	037 1		2130	2200	3	6118	JFSD	08
229	0222	229	0	00694	42BAA	B	D	037 1		2200	2230	3	6118	JFSD	08
226	9042	230	0	00000	42BA0	B	F	615 1		0700	1200	2	6135	PRQE	08
232	0118	231	0	00626	42BAA	B	2	242 1		1200	1600	2	6126	PRQE	08
232	0414	232	0	00000	42BEA	B	B	450 1		1500	1945	3	5079	FXBM	08
233	4008	233	0	00000	42BA0	B	2	799 6		2000	2005	1	3065	FNNW	08
225	0314	233	0	00000	42BDD	B	E	799 6		2300	2400	2	5070	FNNW	08
232	0307	233	0	00000	42BE0	B	D	615 1		2130	2300	3	6116	JFSD	08
233	0213	233	0	00000	42BEA	B	F	800 6		2000	2030	3	6113	JFSD	08
232	0307	233	0	00000	42BEA	B	D	105 2		2300	2400	3	6116	JFSD	08
225	0314	234	0	00000	42B99	B	E	105 2		1600	1800	2	5070	FNNW	08
232	0307	234	0	00000	42BEA	B	D	799 6		0700	0800	3	6116	JFSD	08
233	0213	234	0	00000	42BEA	B	F	800 6		0730	0800	3	6113	JFSD	08
232	0307	234	0	00000	42BEA	B	D	105 2		2400	0700	3	6116	JFSD	08
235	0252	235	0	00000	42BAA	B	F	721 1		1230	1630	2	6132	FNNW	08
219	0210	235	0	00595	42BDA	B	F	799 6		1000	1200	2	6129	PRQE	08
235	0152	235	0	00874	42BAH	B	F	800 6		0900	1100	1	6113	JFSD	08
235	0420	236	0	00000	42BA0	B	F	799 6		2000	2400	4	5074	FNNW	08
236	0252	236	0	00000	42BA0	B	F	799 6		1800	1900	4	6132	FNNW	08
236	0166	236	0	00000	42BAA	B	F	721 1		1400	1630	2	4058	FNNW	08
190	4211	236	0	00000	42BAH	B	F	799 6		0445	0505	1	5077	FXBM	08
235	4681	236	0	00000	42BDA	B	F	105 2		0300	0600	2	5070	FNNW	08
228	0324	236	0	00000	42BDE	B	B	105 2		0700	0900	3	4058	FNNW	08
236	0387	236	0	00000	42BEA	B	F	799 6		0335	0400	2	3068	FNNW	08

Marcon Industries
Record Type: A
MDS: B001B

*** M O D A S II ***
Detail Maintenance Data Report

Summary Report
AUG 90

Total Time	Cum. Crew Size	Total Man-hours	Total Units Produced
214.8	247	520.8	101

Hit <RETURN> to continue, or "\$" to end output: Marcon Industries
M O D A S II *** Page: 1
Record Type: A Detail Maintenance Data Report
MDS: B001B

Summary Report
SEP 90

Total Time	Cum. Crew Size	Total Man-hours	Total Units Produced
162.0	180	306.8	88

Hit <RETURN> to continue, or "\$" to end output:
Marcon Industries *** M O D A S II ***
Record Type: A Detail Maintenance Data Report
MDS: B001B

Summary Report
OCT 90

Total Time	Cum. Crew Size	Total Man-hours	Total Units Produced
295.9	349	757.6	141

Hit <RETURN> to continue, or "\$" to end output:

APPENDIX C

LCOM

LCOM DATA BASE

Failure Rates 3-Digit WUC

WUC		MTBF		
15 F23ME*	C	6.50	0.	X
15 F23N**	C	32.03	0.	X
15 F23NE*	C	91.00	0.	X
15 F23P**	C	18.21	0.	X
15 F23PE*	C	3.79	0.	X
15 F23R**	C	10.56	0.	X
15 F23RE*	C	5.35	0.	X
15 F240**	C	682.0	0.	X
15 F241**	C	184.0	0.	X
15 F242**	C	23.74	0.	X
15 F243**	C	154.0	0.	X
15 F411**	C	30.99	0.	X
15 F412**	C	30.01	0.	X
15 F413**	C	122.0	0.	X
15 F414**	C	298.0	0.	X
15 F421**	C	7.15	0.	X
15 F421E*	C	6.07	0.	X
15 F422**	C	129.0	0.	X
15 F440**	C	954.0	0.	X
15 F441**	C	8.21	0.	X
15 F442**	C	8.02	0.	X
15 F444**	C	251.0	0.	X
15 F451**	C	3.64	0.	X
15 F451E*	C	10.11	0.	X
15 F452**	C	165.0	0.	X
15 F461**	C	1.00	0.	X
15 F461XX	C	30.20	0.	X
15 F462**	C	1.00	0.	X
15 F462XX	C	29.10	0.	X
15 F463**	C	1.00	0.	X
15 F463XX	C	74.56	0.	X
15 F464**	C	1.00	0.	X
15 F464XX	C	30.59	0.	X
15 F465**	C	1.00	0.	X
15 F465XX	C	129.0	0.	X
15 F466**	C	1.00	0.	X
15 F466XX	C	72.30	0.	X
15 F467**	C	6.17	0.	X
15 F467??	C	1.00	0.	C
15 F467XX	C	22.94	0.	X
15 F468**	C	6.87	0.	X
15 F469**	C	52.44	0.	X
15 F469??	C	1.00	0.	C
15 F469XX	C	170.4	0.	X
15 F47A**	C	95.44	0.	X
15 F471**	C	13.99	0.	X
15 F494**	C	34.83	0.	X
15 F494E*	C	6.50	0.	X
15 F495**	C	954.0	0.	X

LCOM DATA BASE

Maintenance Task Times and Resource Requirements

Task	MTTR	VAR	Specialist			
25 R24200	21	1.000H .290HL	431X2	1		
25 R24300	21	2.200H .633HL = lognormal	423X1	1		
25 R24301	21	1.200H .348HL	426C2	2		
25 R24302	21	2.300H .667HL	431X2	2		
25 R4C0WL	32	.800H .232HL	431X2	3		
25 R41100	21	2.900H .341HL	423X1	2		
25 R41101	21	.800H .232HL	431X2	2		
25 R41200	21	1.000H .290HL	423X0	2		
25 R41201	21	2.800H .312HL	423X1	2		
25 R41300	21	1.000H .290HL	423X0	2		
25 R41400	21	4.900H1.421HL	423X0	1	423X1	1
25 R41401	21	5.300H1.537HL	423X1	2		
25 R421E0	21	3.000H .370HL	423X0	1		
25 R421E1	21	3.600H1.044HL	423X0	2		
25 R421E3	21	C				
25 R421T0	21	2.000H .580HL	426T2	1		
25 R42100	21	4.000H1.160HL	423X0	2	426C2	1
25 R42101	21	1.900H .551HL	423X0	2		
25 R42102	21	2.500H .725HL	423X4	2		
25 R42103	21	2.000H .580HL	426C2	2		
25 R42104	21	.900H .261HL	431X2	2		
25 R42200	21	1.300H .377HL	423X0	2		
25 R42201	21	3.000H1.450HL	423X0	2	423X4	1
25 R42202	21	1.400H .406HL	423X4	2		
25 R44000	21	.500H .145HL	431X2	2		
25 R44100	21	1.300H .377HL	423X0	1	431X2	1
25 R44101	21	1.200H .348HL	423X0	2		
25 R44102	21	1.900H .551HL	423X4	2		
25 R44103	21	.700H .203HL	431X2	1		
25 R44200	21	1.600H .464HL	423X0	2		
25 R44201	21	1.500H .435HL	423X0	1	431X2	1
25 R44202	21	2.700H .783HL	423X4	2	431X2	1
25 R44203	21	1.900H .551HL	423X4	2		
25 R44204	21	1.500H .435HL	431P2	2		
25 R44205	21	.700H .203HL	431X2	1		
25 R44400	21	2.000H .580HL	328X0	2		
25 R44401	21	1.900H .551HL	423X0	2		
25 R451E0	21	C				
25 R45100	21	2.500H .725HL	423X0	1	423X4	1
25 R45101	21	2.200H .633HL	423X0	2		
25 R45102	21	3.100H .899HL	423X4	2		
25 R45103	21	13.50H 3.91HL	423X4	2	431R2	1
25 R45200	21	2.400H .696HL	423X4	2		
25 R46100	21	9.500H2.755HL	423X0	2	423X3	1
25 R46101	21	2.400H .696HL	423X3	2		
25 R46200	21	5.800H1.682HL	423X0	1	423X3	1
25 R46201	21	1.000H .290HL	423X0	2		
25 R46202	21	3.100H .899HL	423X3	2		

LCOM DATA BASE

Maintenance Task Networks

Start Node	TASK	Stop Node	Selection Parameter	
30 CALUM		UM0007	FF410**	ENVIR. CONT. SYSTEM
30 UM0007	R41***	R41001	E.44200	R & R FOR 41***
30 UM0007	M41***		E.19900	MINOR MAINT FOR 41***
30 UM0007	H41***		E.35900	CND FOR 41***
30 R41001	SHOP	R41002	D	SHOP NETWORK FOR 41***
30 R41002	Q41***		I	SHOP NETWORK FOR 41***
30 R41002	G41***	I41001	D	SHOP NETWORK FOR 41***
30 I41001	TWDLVL		E.00000	
30 I41001	THRLVL	I41002	E1.0000	
30 I41002	W41***	PCYCLE	E.33000	SHOP REPAIR FOR 41***
30 I41002	K41***	PCYCLE	E.33000	RETEST OK FOR 41***
30 I41002	N41***	PDEPOT	E.34000	NRTS FOR 41***
30 CALUM		UM0008	FF420**	ELECT. PWP. SYSTEM
30 UM0008	R42***	R42001	E.80300	R & R FOR 42***
30 UM0008	M42***		E.17300	MINOR MAINT FOR 42***
30 UM0008	H42***		E.02400	CND FOR 42***
30 R42001	SHOP	R42002	D	SHOP NETWORK FOR 42***
30 R42002	Q42***		I	SHOP NETWORK FOR 42***
30 R42002	G42***	I42001	D	SHOP NETWORK FOR 42***
30 I42001	TWDLVL		E.00000	
30 I42001	THRLVL	I42002	E1.0000	
30 I42002	W42***	PCYCLE	E.33000	SHOP REPAIR FOR 42***
30 I42002	K42***	PCYCLE	E.33000	RETEST OK FOR 42***
30 I42002	N42***	PDEPOT	E.34000	NRTS FOR 42***
30 CALUM		UM0009	FF440**	LIGHTING SYSTEM
30 UM0009	R44***	R44001	E.61800	R & R FOR 44***
30 UM0009	M44***		E.33300	MINOR MAINT FOR 44***
30 UM0009	H44***		E.04900	CND FOR 44***
30 R44001	SHOP	R44002	D	SHOP NETWORK FOR 44***
30 R44002	Q44***		I	SHOP NETWORK FOR 44***
30 R44002	G44***	I44001	D	SHOP NETWORK FOR 44***
30 I44001	TWDLVL		E.00000	
30 I44001	THRLVL	I44002	E1.0000	
30 I44002	W44***	PCYCLE	E.33000	SHOP REPAIR FOR 44***
30 I44002	K44***	PCYCLE	E.33000	RETEST OK FOR 44***
30 I44002	N44***	PDEPOT	E.34000	NRTS FOR 44***
30 CALUM		UM0010	FF450**	HYD. AND PNEU. SYSTEM
30 UM0010	R45***	R45001	E.32700	R & R FOR 45***
30 UM0010	M45***		E.58700	MINOR MAINT FOR 45***
30 UM0010	H45***		E.03600	CND FOR 45***
30 R45001	SHOP	R45002	D	SHOP NETWORK FOR 45***
30 R45002	Q45***		I	SHOP NETWORK FOR 45***
30 R45002	G45***	I45001	D	SHOP NETWORK FOR 45***
30 I45001	TWDLVL		E.00000	
30 I45001	THRLVL	I45002	E1.0000	

APPENDIX D

3-M

CATALOG

OF

3-M AVIATION INFORMATION REPORTS

REPORT TITLE - RELIABILITY AND MAINTAINABILITY SUMMARY

REPORT No. - NAMSO 4790.A7142-01

FREQUENCY OF DISTRIBUTION - QUARTERLY

HIGHLIGHTS OF REPORT - AIRCRAFT: BY TYPE/MODEL/SERIES BY TYCOM/TOTAL NAVY

- DEPICTS RELIABILITY AND MAINTAINABILITY STATISTICS BASED ON AIRFRAME FLIGHT HOURS.
- TOTAL MAINTENANCE ACTIONS AND FAILURES.
- MEAN FLIGHT HOURS BETWEEN MAINTENANCE ACTIONS (MFHBMA).
- MEAN FLIGHT HOURS BETWEEN FAILURES (MFHBF).
- MANHOUR EXPENDITURES.
- ASSEMBLY AND SYSTEM SUMMARIES.
- PRODUCED QUARTERLY ON THREE MONTH DATA BASE.

Published by

NAVY MAINTENANCE SUPPORT OFFICE

Naval Sea Logistics Center
Mechanicsburg, PA 17055-0795

PERIOD - JAN 87 THROUGH MAR 87
DATE - 21 MAY 87

NAVY
RELIABILITY AND MAINTAINABILITY
SUMMARY

NAMSO 4790-A7142-01
PAGE 580
ACFT - F/A-18A

AIRCRAFT - F/A-18A

WUC Nomenclature

754CD BRU32/A AIRCRAFT BOMB EJECTOR ROCK

UNSCD	MAINT	UNSCD	M/H	EMT
MAN	HRS	MAN	PER	PER
HOURS	PER F/H	ACT	ACT	ACT
302	.062	1.8	1.4	
69	.027	6.3	5.9	
223	.091	2.0	1.2	
87	.030	4.3	2.9	
114	.200	3.3	1.1	
60	.088	2.5	1.5	
854	.052	2.3	1.5	

TOTAL	REPAIR	TOTAL	MFHBF
FLIGHT	FAILURE	FAILURE	
HOURS			
4,845	8	32	151.4
2,595	0	2	1,297.5
4,413	6	13	339.5
2,853	0	10	285.3
570	0	0	-
681	0	4	170.3
16,296	14	61	267.1

ML-1	REPAIR	FAILURE	MFHBF
FAILURE			
29.5	8	32	151.4
235.9	0	2	1,297.5
39.4	6	13	339.5
142.7	0	10	285.3
16.3	0	0	-
28.4	0	4	170.3
44.5	14	61	267.1

TOTAL	REPAIR	TOTAL	MFHBF
FLIGHT	FAILURE	FAILURE	
HOURS			
4,845	8	32	151.4
2,595	0	2	1,297.5
4,413	6	13	339.5
2,853	0	10	285.3
570	0	0	-
681	0	4	170.3
16,296	14	61	267.1

COMMAND	TOTAL	REPAIR	FAILURE	MFHBF
	MAINT			
ACTIONS				
CNAL	164	29.5	8	32
FMFLANT	11	235.9	0	2
CNAP	112	39.4	6	13
FMFPAC	20	142.7	0	10
NASC	35	16.3	0	0
NAVRES	24	28.4	0	4
TOTAL	366	44.5	14	61

754CE BRU33/A AIRCRAFT BOMB EJECTOR ROCK

UNSCD	MAINT	UNSCD	M/H	EMT
MAN	HRS	MAN	PER	PER
HOURS	PER F/H	ACT	ACT	ACT
39	.008	1.6	1.2	
21	.005	1.7	.9	
66	.023	3.6	2.6	
154	.009	2.8	2.0	

TOTAL	REPAIR	FAILURE	MFHBF
FLIGHT			
HOURS			
4,845	9	11	440.5
2,595	0	1	4,413.0
4,413	0	8	356.6
2,853	0	21	776.0
570	0	0	-
681	0	4	170.3
16,296	31	91	179.1

ML-1	REPAIR	FAILURE	MFHBF
FAILURE			
25.0	17	44	110.1
216.3	0	3	865.0
33.4	10	18	245.2
67.9	4	22	129.7
14.3	0	0	-
26.2	0	4	170.3
36.5	31	91	179.1

TOTAL	REPAIR	FAILURE	MFHBF
FLIGHT			
HOURS			
4,845	17	44	110.1
2,595	0	3	865.0
4,413	10	18	245.2
2,853	4	22	129.7
570	0	0	-
681	0	4	170.3
16,296	31	91	179.1

75E50 AIRCRAFT PYLONS

UNSCD	MAINT	UNSCD	M/H	EMT
MAN	HRS	MAN	PER	PER
HOURS	PER F/H	ACT	ACT	ACT
35	.007	1.8	1.3	
43	.010	2.0	1.0	
88	.005	1.6	1.0	

TOTAL	REPAIR	FAILURE	MFHBF
FLIGHT			
HOURS			
4,845	3	3	1,615.0
4,413	13	13	339.5
16,296	19	19	857.7

75E51 SUU63/A AIRCRAFT PYLON

UNSCD	MAINT	UNSCD	M/H	EMT
MAN	HRS	MAN	PER	PER
HOURS	PER F/H	ACT	ACT	ACT
300	.062	1.9	1.0	
139	.032	2.0	.8	
41	.015	2.6	1.2	
66	.116	3.0	.9	
559	.034	2.0	.9	

TOTAL	REPAIR	FAILURE	MFHBF
FLIGHT			
HOURS			
4,845	18	20	242.3
4,413	5	5	882.6
2,853	1	3	951.0
570	1	1	570.0
16,296	27	31	525.7

ML-1	REPAIR	FAILURE	MFHBF
FAILURE			
31.5	18	20	242.3
62.2	5	5	882.6
178.3	1	3	951.0
25.9	1	1	570.0
59.5	27	31	525.7

A	B	C	D	E	F	G	H	J	K	L	M
---	---	---	---	---	---	---	---	---	---	---	---

A	The work unit code and its corresponding nomenclature. Data for work unit codes are summarized at the system (2nd) and assembly/set (4th) levels. The major command or Navy-wide total.
B	Number of flight hours reported for the period.
C	Number of unscheduled maintenance actions initiated.

E	Mean flight hours between maintenance actions.
F	Number of failures repaired at the organizational level.
G	Number of maintenance actions confirmed as failures by the action taken code (B,C,Z or 1 thru 9) and a malfunction code other than a conditional malfunction.

H	Mean flight hours between failures.
J	Number of unscheduled maintenance manhours reported on the VIDS/NAF source document.
K	Maintenance manhours per flight hour.
L	Maintenance manhours per maintenance action.
M	Elapsed maintenance time per maintenance action.

NAMSO 4790.A7142-02

1 JANUARY 1988

CATALOG

OF

3-M AVIATION INFORMATION REPORTS

REPORT TITLE - WORK UNIT CODE SYSTEM RELIABILITY AND MAINTAINABILITY SUMMARY

REPORT No. - NAMSO 4790.A7142-02

FREQUENCY OF DISTRIBUTION - QUARTERLY

HIGHLIGHTS OF REPORT

- COMPARES SYSTEM PERFORMANCE FOR AN AIRCRAFT.
- SUMMARIZES RELIABILITY AND MAINTAINABILITY DATA BY MAJOR COMMAND, SPECIFIED WORK UNIT CODE AND AIRCRAFT.
- PROVIDES WORK UNIT CODE PERCENT OF TOTAL AIRCRAFT ACTIONS.

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Naval Sea Logistics Center
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PERIOD - APR 87 THROUGH JUN 87
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NAVY
WORK UNIT CODE SYSTEM
RELIABILITY AND MAINTAINABILITY SUMMARY

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AIRCRAFT	TOTAL FLIGHT HOURS	TOTAL MAINT ACTIONS	MFHBMA	ML 1 REPAIR FAILURE	TOTAL FAILURE	MFHBF	UNSC MAINT MAN HOURS	MAINT		M/H PER		EMT		WUC % OF TOTAL ACFT			
								F/H	PER	ACT	MAINT	ACT	MAINT	ACT	ML 1 FAIL	TOT FAIL	MAN HOURS
A WUC - 65000 NOMENCLATURE - IFF SYSTEMS																	
KA-6D	1,521	39	39.0	11	18	84.5	201	.132	5.2	3.0	.7	.7	.8	.6			
A-6E	17,634	667	26.4	119	296	59.6	4,300	.244	6.4	3.7	.9	.6	.9	.9			
TA-7C	2,670	57	46.8	9	30	89.0	691	.259	12.1	6.9	.9	.6	1.0	1.5			
A-7E	14,784	348	42.5	59	158	93.6	2,113	.143	6.1	4.0	.8	.5	.9	.9			
EA-7L	564	23	24.5	2	4	141.0	295	.523	12.8	5.1	2.1	.8	1.0	3.8			
C-2A	691	14	49.4	1	3	230.3	56	.080	4.0	2.3	.6	.1	.3	.3			
TC-4C	797	8	99.6	2	2	398.5	17	.021	2.1	1.4	.5	.5	.3	.1			
KC-130F	2,742	97	28.3	7	55	49.9	2,149	.784	22.2	8.0	1.4	.3	1.6	3.9			
EC-130Q	841	8	105.1	0	4	210.3	118	.141	14.8	8.6	.6	.0	.5	1.6			
KC-130T	274	12	22.8	1	3	91.3	73	.265	6.0	4.9	2.1	.6	1.2	1.8			
E-2C	3,163	120	26.4	15	47	67.3	862	.272	7.2	4.1	1.5	.6	1.3	1.5			
F/A-18A	21,044	272	77.4	37	67	314.1	951	.045	3.5	2.0	.7	.5	.5	.4			
F/A-18B	3,304	21	157.3	2	5	660.8	101	.030	4.8	2.6	.5	.3	.4	.3			
F-45	2,794	164	17.0	30	90	31.0	1,356	.485	8.3	5.9	1.6	1.5	2.0	1.6			
F-14A	21,582	1,109	19.5	213	546	39.5	7,585	.351	6.8	4.0	1.3	1.0	1.6	1.5			

B	C	D	E	F	G	H	J	K	L	M	N
---	---	---	---	---	---	---	---	---	---	---	---

A	System level work unit code and nomenclature.
B	The identification of the aircraft.
C	Total flight hours for the reporting period.
D	Total system level maintenance actions initiated.
E	Mean flight hours between maintenance actions.

F	Number of repair actions accomplished at the organizational level.
G	Number of maintenance actions confirmed as failures.
H	Mean flight hours between failures.
J	Manhours required for unscheduled maintenance.

K	Maintenance manhours divided by flight hours.
L	Manhours per maintenance action.
M	Elapsed maintenance time per maintenance action.
N	Percentage of effort performed on the WUC relative to that expended on the entire aircraft.

NAMSO 4790.A7142-03

1 JANUARY 1988

CATALOG

OF

3-M AVIATION INFORMATION REPORTS

REPORT IIIIE - RELIABILITY AND MAINTAINABILITY SUMMARY FOR SELECTED WORK UNIT CODES

REPORT No. - NAMSO 4790.A7142-03

FREQUENCY OF DISTRIBUTION - QUARTERLY

HIGHLIGHTS OF REPORT -

- PERMITS COMPARATIVE ANALYSIS OF ENGINES AND AVIONICS EQUIPMENT PERFORMANCE WITHIN VARIOUS AIRCRAFT.
- PORTRAYS THE FOLLOWING INFORMATION FOR WORK UNIT CODES LISTED IN THIS REPORT:
 - AIRCRAFT APPLICATION.
 - RELIABILITY AND MAINTAINABILITY STATISTICS.
 - WUC PERCENT OF TOTAL AIRCRAFT MAINTENANCE ACTIONS, FAILURES AND MAN-HOURS.
- EXCLUDES WORK UNIT CODES HAVING SIX OR LESS MAINTENANCE ACTIONS.

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**Naval Sea Logistics Center
Mechanicsburg, PA 17055-0795**

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NAVY
RELIABILITY AND MAINTAINABILITY SUMMARY
FOR SELECTED WORK UNIT CODES

NAMSO 4790.0712
PAGE 2

AIRCRAFT	TOTAL FLIGHT HOURS	TOTAL MAINT ACTIONS	NOMENCLATURE - AN/APN141(V) ELECTRONIC ALTIMETER SET	MFHBMA	REPAIR FAILURE	TOTAL FAILURE	MFHBF	UNSCD MAINT MAN HOURS	MAINT		M/H		EMI		WUC % OF TOTAL ACT					
									F/H	P/H	ACT	PER	ACT	PER	ACT	MAINT	FAIL	ML1	TOT	MAINT
WUC - 72360																				
EA-6B	5,164	24	215.2		10	12	430.3	56	.011		2.3	1.2				.1		.1		
KA-6D	1,521	8	190.1		2	2	760.5	14	.009		1.7	1.1				.1		.1		
A-6E	17,634	74	238.3		36	44	400.8	210	.012		2.8	1.6				.1		.1		
TA-7C	2,670	134	19.9		9	55	48.5	634	.238		4.7	3.5				2.0		.6		
A-7E	14,784	39	379.1		7	19	778.1	279	.019		7.1	4.3				.1		.1		
C-2A	691	10	69.1		1	4	172.8	314	.454		31.4	5.1				.4		.1		
P-3B	7,691	7	1,098.7		4	4	1,922.8	31	.004		4.5	2.6				.0		.1		
TOTAL	74,403	2,079	35.8		235	947	78.6	12,153	.163		5.8	3.6				1.0		.4		
WUC - 72380																				
NOMENCLATURE - AN/APN153(V) DOPPLER RADAR NAV SET																				
ERA-3B	455	18	25.3		1	7	65.0	268	.588		14.9	7.6				1.3		.2		
A-4E	2,235	27	82.8																	
A-4F	1,146	32	35.8																	
EA-6A	831	60	13.9																	
EA-6B	5,164	163	31.7																	
A-6E	17,634	921	19.1																	
A-7E	14,784	13	1,137.2																	
TC-4C	797	33	24.2																	
P-3A	730	10	73.0																	
P-3B	7,691	213	36.1		22	130	59.2	2,598	.338		12.2	9.3				1.4		.5		
TOTAL	51,467	1,490	34.5		324	923	55.8	14,103	.274		9.5	6.1				.9		.7		
WUC - 72390																				
NOMENCLATURE - AN/APN154(V) RADAR BEACON SET																				
A-4M	3,616	11	328.7		3	5	723.2	78	.021		7.0	6.4				.1		.1		
EA-6B	5,164	42	123.0		10	19	271.8	437	.085		10.4	4.6				.2		.2		
KA-6D	1,521	17	89.5		3	7	217.3	70	.046		4.1	2.5				.3		.2		
A-6E	17,634	192	91.8		49	85	207.5	1,291	.073		6.7	4.2				.2		.2		
TA-7C	2,670	23	116.1		5	10	267.0	99	.037		4.3	2.1				.3		.3		
A-7E	14,784	81	182.5		31	42	352.0	243	.016		3.0	2.0				.2		.3		
F-14A	21,582	205	105.3		52	85	253.9	918	.043		4.5	2.7				.2		.3		
TOTAL	66,971	571	117.3		153	253	264.7	3,136	.047		5.5	3.3				.2		.2		
Please refer to NAMS0 Report 4790.A7142-02 for format definitions.																				
The difference between this report (NAMS0 4790.A7142-03) and the preceding (NAMS0 4790.A7142-02) is that data is given by the first four positions of the work unit code. In NAMS0 Report 4790.A7142-02, the data is summarized by the first two positions of the work unit code. Additionally, this report is restricted to work unit codes identifying engine and avionics equipments.																				

Please refer to NAMSO Report 4790.A7142-02 for format definitions.
The difference between this report (NAMSO 4790.A7142-03) and the preceding (NAMSO 4790.A7142-02) is that data is given by the first four positions of the work unit code. In NAMSO Report 4790.A7142-02, the data is summarized by the first two positions of the work unit code. Additionally, this report is restricted to work unit codes identifying engine and avionics equipments.

1 JANUARY 1988

CATALOG

OF

3-M AVIATION INFORMATION REPORTS

REPORT TYPE - RELIABILITY AND MAINTAINABILITY TREND ANALYSIS SUMMARY

REPORT No. - NAMSO 4790.A7142-04

FREQUENCY OF DISTRIBUTION - QUARTERLY

HIGHLIGHTS OF REPORT

- DEPICTS RELIABILITY AND MAINTAINABILITY STATISTICS FOR A 4-DIGIT WUC.
- PROVIDES FOR MULTIPLE TIME FRAMES FOR TREND ANALYSIS.
- INDICATES COMPARATIVE FAILURE RANKING OF THE WUC IN RELATION TO ALL WUCs FOR THE AIRCRAFT.

Published by

NAVY MAINTENANCE SUPPORT OFFICE

**Naval Sea Logistics Center
Mechanicsburg, PA 17055-0795**

WUC	NOMENCLATURE	PERIOD	TOTAL FLIGHT HOURS	TOTAL MAINT ACTIONS	MFHBM	MLI REPAIR FAILURE	TOTAL FAILURE	MFHBF	UNSC MAINT HOURS	UNSC M/H PER F/H	EMT PER MAINT ACT	FAIL RANK
727H AN/APS116() RADAR SET		OCT86-DEC86	14,253	718	19.9	129	429	33.2	8,455	.593	11.8	9.0
		JUL86-SEP86	13,823	714	19.4	146	409	33.8	7,684	.556	10.8	7.7
		APR86-JUN86	14,305	809	17.7	162	444	32.2	9,980	.698	12.3	7.8
		JAN86-MAR86	15,825	898	17.6	177	497	31.8	10,415	.658	11.6	8.1
		OCT85-DEC85	13,447	654	20.6	123	346	38.9	8,031	.597	12.3	8.1
729D AN/APN202 RADAR BEACON SET		JUL85-SEP85	16,414	887	18.5	205	476	34.5	11,808	.719	13.3	8.5
		APR87-JUN87	11,020	47	234.5	14	19	580.0	197	.018	4.2	2.9
		JAN87-MAR87	8,305	52	159.7	14	26	319.4	354	.043	6.8	4.3
		OCT86-DEC86	14,253	72	198.0	21	34	419.2	442	.031	6.1	4.0
		JUL86-SEP86	13,823	70	197.5	18	30	460.8	426	.031	6.1	3.7
729F OUT8()/AP CONV CONT GROUP R		APR86-JUN86	14,305	62	230.7	27	41	348.9	363	.025	5.9	3.2
		JAN86-MAR86	15,825	80	197.8	33	50	316.5	389	.025	4.9	3.3
		OCT85-DEC85	13,447	77	174.6	20	36	373.5	455	.034	5.9	3.7
		JUL85-SEP85	16,414	63	260.5	24	32	512.9	240	.015	3.8	2.3
		APR87-JUN87	11,020	229	48.1	39	136	81.0	2,618	.238	11.4	6.9
		JAN87-MAR87	8,305	185	44.9	48	127	65.4	1,962	.236	10.6	6.8
		OCT86-DEC86	14,253	347	41.1	57	234	60.9	4,740	.333	13.7	8.7
		JUL86-SEP86	13,823	280	49.4	59	182	76.0	3,483	.252	12.4	7.7
		APR86-JUN86	14,305	326	43.9	73	200	71.5	3,704	.259	11.4	6.9
		JAN86-MAR86	15,825	357	44.3	91	246	64.3	4,139	.262	11.6	7.1
		OCT85-DEC85	13,447	346	38.9	70	205	65.6	3,716	.276	10.7	6.6
		JUL85-SEP85	16,414	328	50.0	58	192	85.5	4,507	.275	13.7	8.2

A		B		C		D	
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A The first four positions of the work unit code and its corresponding nomenclature.

B The reporting period selected for the report. Multiple time periods may be included in the report.

C Please refer to NAMSO Report 4790.A7142-01 or 4790.A7142-02 for format definitions.

D The comparative failure ranking of the work unit code for the specified period as compared with all work unit codes for the aircraft.

NAMSO 4790.A7142-05

1 JANUARY 1988

CATALOG

OF

3-M AVIATION INFORMATION REPORTS

REPORT TITLE - FIVE DIGIT WUC RELIABILITY AND MAINTAINABILITY TREND ANALYSIS SUMMARY

REPORT No. - NAMSO 4790.A7142-05

FREQUENCY OF DISTRIBUTION - QUARTERLY

HIGHLIGHTS OF REPORT

- DEPICTS RELIABILITY AND MAINTAINABILITY STATISTICS FOR A 5-DIGIT WUC.
- PROVIDES FOR MULTIPLE TIME FRAMES FOR TREND ANALYSIS.
- INDICATES COMPARATIVE FAILURE RANKING OF THE WUC IN RELATION TO ALL WUCs FOR THE AIRCRAFT.

Published by

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**Naval Sea Logistics Center
Mechanicsburg, PA 17055-0795**

PERIOD - APR 87 THROUGH JUN 87
DATE - 21 AUG 87

LANT NAVY
FIVE DIGIT WORK UNIT CODE RELIABILITY AND
MAINTAINABILITY TREND ANALYSIS SUMMARY

NAMSO 4790.A7142-05
PAGE 242
ACFT - A-6E

WUC	NOMENCLATURE	PERIOD	TOTAL FLIGHT HOURS	TOTAL MAINT ACTIONS	MFHBMA	MLI REPAIR FAILURE	TOTAL FAILURE	MFHBF	UNSC MAINT MAN HOURS	UNSC MAINT M/H F/H	M/H PER MAINT ACT	EMT PER MAINT ACT	FAIL RANK
736G1	C9535/ASQ155 COMPUTER CONTR	APR87-JUN87	5,768	190	30.4	25	84	68.7	1,086	.188	5.7	3.3	18
		JAN87-MAR87	6,340	226	28.1	37	106	59.8	1,733	.273	7.7	4.0	14
		OCT86-DEC86	7,015	208	33.7	42	112	62.6	1,512	.216	7.3	3.9	14
		JUL86-SEP86	6,954	183	38.0	35	81	85.9	1,341	.193	7.3	4.0	25
		APR86-JUN86	6,035	189	31.9	37	89	67.8	1,427	.236	7.5	4.1	17
		JAN86-MAR86	6,782	176	38.5	29	90	75.4	1,560	.230	8.9	4.2	23
		OCT85-DEC85	6,395	149	42.9	27	75	85.3	1,028	.161	6.9	3.6	23
736G2	CV3163/ASQ155 A-D/D-A CONVE	JUL85-SEP85	6,574	152	43.3	26	78	84.3	939	.143	6.2	3.4	28
		APR87-JUN87	5,768	232	24.9	12	117	49.3	2,130	.369	9.2	5.4	10
		JAN87-MAR87	6,340	221	28.7	9	110	57.6	2,274	.359	10.3	5.9	12
		OCT86-DEC86	7,015	283	24.8	18	138	50.8	3,043	.434	10.8	6.0	10
		JUL86-SEP86	6,954	353	19.7	9	167	41.6	3,976	.572	11.3	6.4	7
		APR86-JUN86	6,035	264	22.9	20	138	43.7	2,798	.464	10.6	5.9	6
		JAN86-MAR86	6,782	217	31.3	16	112	60.6	2,246	.331	10.3	5.6	12
736G3	CV3163/ASQ155 A-D/D-A CONV	OCT85-DEC85	6,395	287	22.3	13	134	47.7	2,482	.388	8.6	4.9	7
		JUL85-SEP85	6,574	247	26.6	10	108	60.9	2,238	.340	9.1	4.9	16
		APR87-JUN87	5,768	14	412.0	0	10	576.8	42	.007	3.0	2.6	262
		JAN87-MAR87	6,340	19	333.7	1	16	396.3	126	.020	6.6	6.1	183
		OCT86-DEC86	7,015	36	194.9	0	33	212.6	203	.029	5.6	4.4	89
		JUL86-SEP86	6,954	31	224.3	0	30	231.8	155	.022	5.0	4.0	104
		APR86-JUN86	6,035	17	355.0	0	17	355.0	76	.013	4.5	3.5	171
		JAN86-MAR86	6,782	20	339.1	0	19	356.9	3	.000	.2	.2	173
		OCT85-DEC85	6,395	25	255.8	0	18	355.3	4	.001	.2	.1	167
		JUL85-SEP85	6,574	26	252.8	0	26	252.8	289	.044	11.1	6.0	121

A	B	C	D
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A	The first five positions of the work unit code and its corresponding nomenclature.
B	The reporting period selected for the report. Multiple time periods may be included in the report.

C Please refer to NAMSO Report 4790.A7142-01 or 4790.A7142-02 for format definitions.

D The comparative failure ranking of the work unit code for the specified period as compared with all work unit codes for the aircraft.

1 JANUARY 1988

CATALOG

OF

3-M AVIATION INFORMATION REPORTS

REPORT TITLE - RELIABILITY AND MAINTAINABILITY SUMMARY FOR SELECTED EQUIPMENTS

REPORT No. - NAMSO 4790.A7298-01

FREQUENCY OF DISTRIBUTION - ON DEMAND

HIGHLIGHTS OF REPORT

- ALLOWS RELIABILITY AND MAINTAINABILITY COMPARISON BY ACTIVITY, WORK UNIT CODE, AIRCRAFT OR OTHER VARIABLE PARAMETERS AS REQUESTED.
- CUSTOMER SELECTS AIRCRAFT, WORK UNIT CODES AND DATE RANGE.
- PROVIDES WUC ASSEMBLY AND SYSTEM SUMMARIES.

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**Naval Sea Logistics Center
Mechanicsburg, PA 17055-0795**

RELIABILITY AND MAINTAINABILITY SUMMARY
FOR SELECTED EQUIPMENTS

PERIOD - MAY 87 THROUGH JUL 87
DATE - 17 OCT 87

AIRCRAFT - SH-60B

A

WUC NOMENCLATURE ACTIVITY INDIC CONTROL

WUC	NOMENCLATURE	ACTIVITY	INDIC	CONTROL	TOTAL FLIGHT HOURS	TOTAL MAINT ACTIONS	MFHBM	ML 1 REPAIR FAILURE	TOTAL FAILURE	MFHBF	UNSC MAINT HOURS	MAINT M/H PER F/H	EMI PER MAINT ACT
74191	C10486()/ASQ164	HSL-41	HSL-43	DET 5	2,136	15	142.4	0	4	534.0	52	.024	3.5
		HSL-43	DET 8		298	1	298.0	0	1	298.0	6	.021	6.4
		HSL-45			707	2	353.5	1	1	707.0	1	.001	.5
		NATC ROTARY WIN			518	3	172.7	2	2	259.0	10	.019	3.3
		TOTAL			6,468	22	294.0	4	9	718.7	71	.011	3.2
74192	C10487()/ASQ164	HSL-40	HSL-41		502	4	125.5	0	1	502.0	20	.040	5.1
		HSL-43	DET 11		2,136	4	534.0	0	0	534.0	7	.003	1.6
		HSL-43			387	2	193.5	1	2	193.5	56	.144	27.9
		HSL-43	DET 5		245	1	245.0	0	1	245.0	11	.045	11.1
		HSL-43	DET 8		298	2	149.0	0	0	298.0	2	.006	.9
		NATC ROTARY WIN			707	1	707.0	1	1	707.0	0	.000	.3
		TOTAL			6,468	17	380.5	2	5	1,293.6	99	.015	5.8
TOT 74190	AN/ASQ164()	CONTROL	HSL-40		502	4	125.5	0	1	502.0	20	.040	5.1
		HSL-44			276	1	276.0	0	0	276.0	1	.004	1.0
		HSL-41			2,136	19	112.4	0	4	534.0	59	.027	3.1
		HSL-43	DET 11		387	2	193.5	1	2	193.5	56	.144	27.9
		HSL-43			245	1	245.0	0	1	245.0	11	.045	11.1
		HSL-43	DET 5		298	3	99.3	0	1	298.0	8	.028	2.7
		HSL-43	DET 8		707	4	176.8	2	2	353.5	2	.003	.5
		HSL-45			518	3	172.7	2	2	259.0	10	.019	3.3
		NATC ROTARY WIN			176	4	44.0	1	1	176.0	5	.028	4.2
		TOTAL			6,468	41	157.8	6	14	462.0	172	.027	4.2

A	B	C	D	E	F	G	H	J	K	L
---	---	---	---	---	---	---	---	---	---	---

A	Aircraft and work unit codes as specified by the user. Data for work unit codes are summarized at the system (2nd) and assembly/set (4th) levels. Variable data field as desired by user. Can include activity, BU/SER, time frame, constants, etc.
B	Number of flight hours reported.
C	

D	Number of unscheduled maintenance actions initiated.
E	Mean flight hours between maintenance actions.
F	Number of failures repaired at the organizational level and total failures at all levels.
G	Mean flight hours between failures.

H	Number of unscheduled maintenance manhours reported on the VIPS/NAF source document.
J	Maintenance manhours per flight hour.
K	Maintenance manhours per maintenance action.
L	Elapsed maintenance time per maintenance action.

APPENDIX E

RAC

5.6 MICROCIRCUITS, SAW DEVICES**DESCRIPTION**
Surface Acoustic Wave Devices

$$\lambda_p = 2.1 \pi_Q \pi_E \text{ Failures}/10^6 \text{ Hours}$$

Quality Factor - π_Q

Screening Level	π_Q
10 Temperature Cycles (-55°C to +125°C) with end point electrical tests at temperature extremes.	.10
None beyond best commercial practices.	1.0

Environmental Factor - π_E

Environment	π_E
G_B	.5
G_F	2.0
G_M	4.0
N_S	4.0
N_U	6.0
A_{IC}	4.0
A_{IF}	5.0
A_{UC}	5.0
A_{UF}	8.0
A_{RW}	8.0
S_F	.50
M_F	5.0
M_L	12
C_L	220

5.7 MICROCIRCUIT^S, MAGNETIC BUBBLE MEMORIES

The magnetic bubble memory device in its present form is a non-hermetic assembly consisting of the following two major structural segments:

1. A basic bubble chip or die consisting of memory or a storage area (e.g., an array of minor loops), and required control and detection elements (e.g., generators, various gates and detectors).
2. A magnetic structure to provide controlled magnetic fields consisting of permanent magnets, coils, and a housing.

These two structural segments of the device are interconnected by a mechanical substrate and lead frame. The interconnect substrate in the present technology is normally a printed circuit board. It should be noted that this model does not include external support microelectronic devices required for magnetic bubble memory operation. The model is based on Reference 33. The general form of the failure rate model is:

$$\lambda_p = \lambda_1 + \lambda_2 \text{ Failures}/10^6 \text{ Hours}$$

where:

λ_1 = Failure Rate of the Control and Detection Structure

$$\lambda_1 = \pi_Q [N_C C_{11} \pi_{T1} \pi_W + (N_C C_{21} + C_2) \pi_E] \pi_D \pi_L$$

λ_2 = Failure Rate of the Memory Storage Area

$$\lambda_2 = \pi_Q N_C (C_{12} \pi_{T2} + C_{22} \pi_E) \pi_L$$

Chips Per Package - N_C

N_C = Number of Bubble Chips per
Packaged Device

Temperature Factor - π_T

$$\pi_T = (.1) \exp \left[\frac{-E_a}{8.63 \times 10^{-5}} \left(\frac{1}{T_J + 273} - \frac{1}{298} \right) \right]$$

Use:

E_a = .8 to Calculate π_{T1}

E_a = .55 to Calculate π_{T2}

T_J = Junction Temperature ($^{\circ}\text{C}$),
 $25 \leq T_J \leq 175$

T_J = $T_{\text{CASE}} + 10^{\circ}\text{C}$

Device Complexity Failure Rates for Control and
Detection Structure - C_{11} and C_{21}

$$C_{11} = .00095(N_1)^{.40}$$

$$C_{21} = .0001(N_1)^{.226}$$

N_1 = Number of Dissipative Elements
on a Chip (gates, detectors,
generators, etc.), $N_1 \leq 1000$

NONELECTRONIC PARTS RELIABILITY DATA 1991

Prepared by:

William Denson, Greg Chandler,
William Crowell, & Rick Wanner

Reliability Analysis Center
PO Box 4700
Rome, NY 13440 8200

Under contract to:

Rome Laboratory
Griffiss AFB, NY 13441-5700



Reliability Analysis Center

A DoD Information Analysis Center

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Part Description	Qual Lev	App Env	Data Source	Fail Per E6 Hours	Total Failed	Operating Hours (E6)	Detail Page
Absorber, Surge	Com	GB	13567-021 <	0.0210	0	47.5696	3-1
Accelerometer (Summary)				24.8331			
Accelerometer				49.2154			
	Com	AI		89.0991			
			NPRD-082	534.1592	86	0.1610	3-1
			NPRD-096	14.8620	7	0.4710	3-1
	Mil			42.5082			
		AI		168.5923			
			16953-000	111.1108	65	0.5850	3-1
			25199-000	280.5080	2094	7.4650	3-1
			NPRD-106	153.7490	367	2.3870	3-1
	DOR		13253-000	0.4342	143	329.3300	3-1
	GM			49.2490			
			25199-000	277.8615	182	0.6550	3-1
			NPRD-067	12.1951	2	0.1640	3-1
			NPRD-084	35.6761	301	8.4370	3-1
			NPRD-095 <	27.0270	0	0.0370	3-1
	SF		10219-034 <	8.9286	0	0.1120	3-1
	Unk			46.6686			
		A	14182-001	236.6061	-	-----	3-1
		G	14182-001	52.5229	-	-----	3-1
		SF	14182-001	8.1790	-	-----	3-1
Accelerometer, Angular				1.3034			
	Mil	DOR		4.0922			
			11233-000 <	3.9683	0	0.2520	3-1
			13253-000 <	0.2028	0	4.9300	3-1
			NPRD-106	113.4017	22	0.1940	3-1
	Unk			20.3839			
		A	14182-001	113.4016	-	-----	3-1
		GF	14182-001	3.6640	-	-----	3-1
Accelerometer, Forced Balanced	Unk	GM	18459-000	26.6332	8	0.3004	3-1
Accelerometer, Linear				5.6467			
	Mil			37.8108			
		AI	NPRD-106	603.1720	114	0.1890	3-1
	DOR			0.3539			
			11233-000 <	7.9365	0	0.1260	3-1
			13253-000 <	2.2222	0	0.4500	3-1
			NPRD-111 <	0.4444	0	2.2500	3-1
	Unk			34.8105			
		A	14182-001	603.1724	-	-----	3-1
		GF	14182-001	2.0090	-	-----	3-1
Accelerometer, Pendulum (Summary)				4.0543			
	Com	AI		3.7037			
	Mil	DOR		1.9234			
	Unk			6.0210			
		A		3.7040			
		AUF		13.5800			
		GF		1.9240			
Accelerometer, Pendulum				2.4999			
	Com	AI	NPRD-079	3.7037	1	0.2700	3-1
	Mil	DOR		1.9234			
			13253-000	1.9231	6	3.1200	3-1
			NPRD-061	1.9237	6	3.1190	3-1

APPENDIX F

FAA

SERVICE DIFFICULTY REPORT DATA
FOR THE PERIOD OF JANUARY 1, 1985 TO DATE OF PRINT
BOEING 767 GROUP CABIN EMERGENCY SLIDES
SORTED BY OPERATOR, 767 MODEL

DATE OF PRINT IS AUG 09, 1991 PAGE 3

FOR MARY ELLEN MILLER CONTROL NUMBER PI-06-0201

ATA	COMP MAKE	COMP MODEL	PART NAME	CONDITION LOCATION	ACFT MODEL	ACFT SERIAL	ENG MODEL	ENG SERIAL	PROP MODEL	PROP SERIAL	T ORGN PP	NAT	SGO	NUMH	ISO	CONTROL NO
2565			SQUIB	WONT TEST	767231											
				OVERWING SLIDE	22570											
				STL - FLIGHT 720 - AT DEPARTURE, RIGHT HAND OVERWING SLIDE SQUIB WOULD NOT TEST. CLEANED CONNECTOR ON POWER SUPPLY. OP CHECK NORMAL. FLIGHT DISPATCHED. CHECK C-60 3/17/88 LAX.												
2565			SQUIB CIRCUIT	FAILED TEST	767231											
				BATTERY CONNECT	22570											
				JFK - FLIGHT 826 - DURING PREFLIGHT, LEFT AND RIGHT OVERWING EMERGENCY ESCAPE SLIDE FAILED SQUIB TEST. RESEATED LEFT AND RIGHT BATTERY PACK CONNECTIONS. OP CHECKS NORMAL. CHECK C-18 7/26/88 LAX.												
2565	PICO	101654101		FAILED	767											
				SUPPORTING TUBE												
				AT ROUTINE 3 YEAR SCHEDULED OVERHAUL THE 767 LEFT OFFWING SLIDE NR25703-3, SERIAL NR L54-020, EXPERIENCED TWO SEAM SEPARATIONS DURING INFLATION TEST. THE FIRST SEAM FAILURE RESULTED IN A FUNCTIONABLE SLIDE DISABLING ONLY A PORTION OF THE SUPPORTING TUBES. THE SUBSEQUENT SEAM FAILURE OCCURRED DURING AN ESTIMATED TWO MINUTE TIME PERIOD AFTER REINFLATION OF THE SLIDE.												
2565	PICO		BOTTLE	LEAKING	767222											
			130104127	DOOR L1	21880											
				MAINTENANCE REPORTED THE DOOR 1 LEFT DOOR SLIDE PRESSURE GAUGE PRESSURE READING ZERO. REPLACED SLIDE ASSEMBLY. S/D - F												
				OUND PRESSURE CYLINDER LEAKING AT 90 DEGREE ELBOW ON GAUGE. O-RING AND BACKUP RING HAD BEEN REVERSED DURING INSTALLATION BY PICO.												
2565			BOTTLE	LOW PRESSURE	767222											
			130104	DOOR IR SLIDE	21874											
				SLIDE PRESSURE AT DOOR IR IS LOW. S/D - REPLACED SLIDE ASSEMBLY BOTTLE PRESSURE BELOW LIMIT. NO OTHER DISCREPANCY.												
2565	BFGOODRICH	101651303	BOTTLE	LOW PRESSURE	767222											
				2R DOOR	21868											
				BOS - FLIGHT 96 - DOOR 2R SLIDE HAS LOW PRESSURE. S/D - REPLACED SLIDE PER MM 25-66-01.												
2565	PICO	130104127	PACKING	MISINSTALLED	767222											
				BOTTLE GAUGE	21863											
				NR 2 RIGHT DOOR SLIDE BOTTLE PRESSURE LOW. S/D - O-RING AND BACKUP RING FOR ELBOW ON GAUGE REVERSED DURING INSTALLATION BY PICO.												
2565	PICO	130104127	PACKING	MISINSTALLED	767222											
				BOTTLE GAUGE	21862											
				DOOR IR SLIDE BOTTLE PRESSURE LOW. S/D - PACKING AND BACKUP RING FOR ELBOW ON GAUGE REVERSED DURING INSTALLATION BY PICO.												
2565			SLIDE	LOW PRESSURE	767222											
				NR 1 ENTRY DOOR	21873											
				NR 1 LEFT SLIDE PRESSURE LOW. S/D - REPLACED 1 LEFT SLIDE ASSEMBLY. RESERVOIR PRESSURE BELOW LIMIT. NO OTHER DISCREPA												
				PREPARED BY OPERATIONAL SYSTEMS BRANCH AVN 120												

APPENDIX G

CARRIER A

PREMATURE REMOVAL RATE
RA N K E D B Y R E M O V A L R A T E
FOR PERIOD OF 04/91 THRU 06/91

FLEET

PREMATURE REMOVAL RATE RANK	MR NUMBER	N A M E	NUMBER OF PREMATURE REMOVALS	REMOVAL RATE / 1000 UNIT HOURS	NUMBER VERIFIED FAILURES	PERCENT VERIFIED FAILURES
1	25307	COFFEE MAKER	194	2.41	69	36
2	25359	OVEN	108	1.34	48	44
3	23923	CDU-AC C	75	.93	16	21
4	21392	CONTROL-CABIN P	67	.83	7	10
5	31312	RECORDER-FLT	59	.73	29	49
6	23006	REPRODUCER-MUSI	58	.72	35	60
6	23222	PANEL-VHF COMM	58	.72	39	67
7	23917	UNIT - ACARS MA	57	.71	3	5
8	22126	PANEL-AUTOPILOT CONTROL	55	.68	20	36
9	40207	CDU - FLT MANAGEMENT	105	.65	58	55
9	49600	MODULE-APU CONT	52	.65	*	*
10	30007	MODULE ASS-WIND/PIL HEAT	47	.58	16	34
11	43114	RECEIVER-TRANS	45	.56	10	22
12	32421	MAIN LANDING GEAR BRAKE	166	.52	*	*
12	42254	RECEIVER-VHF	84	.52	18	21
13	21391	PANEL-CABIN PRESS CONTROL	41	.51	15	37
14	23283	TRANSCIEVER	38	.47	7	18
14	25343	DISPENSER-COFFE	113	.47	36	32
15	24533	PANEL-BUS PROTECTION	32	.40	4	13
15	42235	PANEL-VHF NAV	64	.40	32	50
16	30413	CONTROLLER-WINDOW HEAT	126	.39	5	4
16	43239	PANEL-9 C	31	.39	14	45
17	23545	UNIT-REMOTE COCKPIT AUDIO	30	.37	5	17
18	23314	AMPLIFIER-PUBLI	29	.36	9	31
19	24349	BATTERY	28	.35	2	7
19	41290	INDICATOR-STANDBY ATTITUDE	28	.35	10	36
19	43215	TRANSPONDER-ATC	28	.35	4	14
19	49503	SWITCH-3 SPEED CETRIFUGAL	28	.35	5	18
20	23512	PANEL-AUDIO SELECTOR	80	.33	36	45

* INDICATES SHOP DATA INCOMPLETE

APPENDIX H

AIRCRAFT MANUFACTURER A

SYSTEM SCHEDULE INTERRUPTION SUMMARY

ATA SYSTEM	DELAYS>15'	CXN	ATB	DIV	SCH INT	SCH INT PER 100 REV DEP
01 AIRCRAFT	3.00	0.00	0.00	0.00	3.00	0.004
08 LEVELING & WEIGHING	1.00	0.00	0.00	0.00	1.00	0.001
21 AIR CONDITIONING	143.00	1.00	1.00	0.00	145.00	0.203
22 AUTOMATIC FLIGHT	16.33	0.00	0.00	0.00	16.33	0.023
23 COMMUNICATIONS	106.67	1.00	0.00	0.00	107.67	0.151
24 ELECTRICAL POWER	116.67	2.00	0.00	0.00	118.67	0.166
25 EQUIP & FURNISHINGS	30.70	0.00	0.00	0.00	30.70	0.043
26 FIRE PROTECTION	27.50	0.00	0.00	2.00	29.50	0.041
27 FLIGHT CONTROLS	221.58	7.50	6.33	0.00	235.42	0.330
28 FUEL	237.33	3.00	2.00	1.00	243.33	0.341
29 HYDRAULIC POWER	79.50	1.00	1.00	0.00	81.50	0.114
30 ICE & RAIN PROTECT	11.83	0.00	0.00	0.00	11.83	0.017
31 INDICATING/RECORDING	92.42	5.00	0.00	0.00	97.42	0.137
32 LANDING GEAR	124.33	2.00	3.50	0.00	129.83	0.182
33 AIRCRAFT LIGHTING	20.00	0.00	0.00	0.00	20.00	0.028
34 NAVIGATION	80.00	1.00	1.00	2.00	84.00	0.118
35 OXYGEN	6.00	0.00	0.00	0.00	6.00	0.008
36 PNEUMATICS	115.43	3.00	0.00	0.00	118.43	0.166
38 WATER & WASTE	42.83	0.00	0.00	0.00	42.83	0.060
45 CENTRAL MAINT SYS	7.00	0.00	0.00	0.00	7.00	0.010
49 AUXILIARY POWER	55.58	0.00	0.00	0.00	55.58	0.078
52 DOORS	35.33	1.00	0.00	0.00	36.33	0.051
53 FUSELAGE	2.00	0.00	0.00	0.00	2.00	0.003
54 NACELLES & PYLONS	0.33	0.00	0.00	0.00	0.33	0.000

BCAG RELIABILITY & MAINTAINABILITY ENGINEERING PERIOD: 08-01-90 THROUGH 07-31-91
REPORT: 331 (09-06-91) DEPARTURES: 71,331

SYSTEM SCHEDULE INTERRUPTION SUMMARY

ATA SYSTEM	DELAYS>15'	CMN	ATB	DIV	SCH INT	SCH INT PER 100 REV DEP
57 WING	5.67	1.00	0.00	0.00	6.67	0.009
71 POWER PLANT	0.20	0.00	0.00	0.00	0.20	0.000
72 ENGINE (MFG COMP)	36.58	2.00	2.00	0.50	41.08	0.058
73 ENGINE FUEL & CTRL	204.17	7.00	1.33	0.00	212.50	0.298
74 ENGINE IGNITION	17.00	0.00	0.00	0.00	17.00	0.024
75 ENGINE AIR	50.83	0.00	0.33	0.00	51.17	0.072
76 ENGINE CONTROLS	6.50	0.00	0.00	0.00	6.50	0.009
77 ENGINE INDICATING	16.33	2.50	0.00	0.00	18.83	0.026
78 ENGINE EXHAUST	52.75	1.00	1.50	0.00	55.25	0.077
79 ENGINE OIL	50.08	3.00	1.00	1.50	55.58	0.078
80 ENGINE STARTING	69.50	0.00	1.00	0.00	70.50	0.099
TOTALS ATA 01 THRU 57	1582.05	28.50	14.83	5.00	1630.38	2.286
TOTALS ATA 71 THRU 80	503.95	15.50	7.17	2.00	528.62	0.741
TOTALS	2086.00	44.00	22.00	7.00	2159.00	3.027

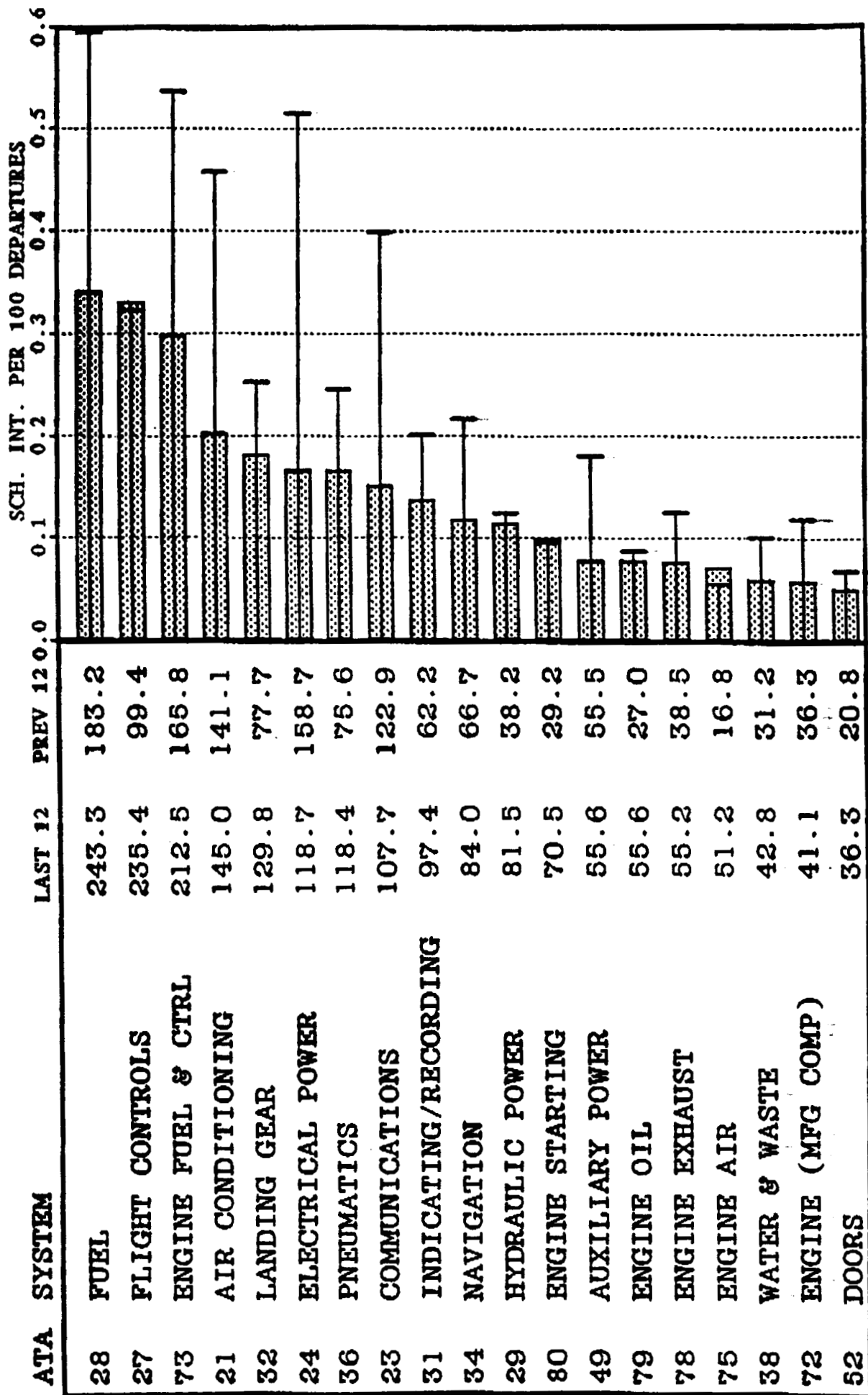
BCRG RELIABILITY & MAINTAINABILITY ENGINEERING PERIOD: 08-01-90 THROUGH 07-31-91
REPORT: 331 (09-06-91) DEPARTURES: 71,331

SYSTEM SCHEDULE INTERRUPTION SUMMARY

(DELAYS > 15 MIN, CANCELLATIONS, AIR TURNBACKS AND DIVERSIONS)

PERIOD ENDING 07-31-91

LAST 12 MONTHS
PREVIOUS 12 MONTHS



SYSTEM SCHEDULE INTERRUPTION SUMMARY

(DELAYS > 15 MIN, CANCELLATIONS, AIR TURNOCKS AND DIVERSIONS)

PERIOD ENDING 07-31-91

LAST 12 MONTHS

PREVIOUS 12 MONTHS



SCH. INT. PER 100 DEPARTURES

0.1 0.2 0.3 0.4 0.5 0.6

ATA SYSTEM

LAST 12 PREV 12 0.0

25 EQUIP & FURNISHINGS

18.2

30.7

26 FIRE PROTECTION

22.3

29.5

33 AIRCRAFT LIGHTING

17.7

20.0

77 ENGINE INDICATING

6.0

18.8

74 ENGINE IGNITION

8.3

17.0

22 AUTOMATIC FLIGHT

13.8

16.3

30 ICE & RAIN PROTECT

18.3

11.8

45 CENTRAL MAINT SYS

8.0

7.0

57 WING

5.0

6.7

76 ENGINE CONTROLS

16.2

6.5

35 OXYGEN

6.7

6.0

01 AIRCRAFT

3.0

3.0

53 FUSELAGE

2.0

2.0

08 LEVELING & WEIGHING

0.0

1.0

71 POWER PLANT

1.0

0.2

APPENDIX I

AIRCRAFT MANUFACTURER B

LCHD-240 /90-

22/06/90

IN-SERVICE DATA MANAGEMENT

FLEET

DELAYS >15 MINUTES

SYSTEM MECHANICAL DELAY AND CANCELLATION ANALYSIS

DATA PERIOD: 1 / 1 / 89 THRU 31 / 12 / 89 INCLUSIVE

ATA SYS	ATA CHAPTER DESCRIPTION	RANK	NO. INCIDENTS	RATE 100 REV.DEPT	% RATE	CLM % RATE	NO. HOURS	HOURS 100 REV.DEPT	% HOUR RATE	HOURS/ INCIDENT	RELIABILITY
32	LANDING GEAR	1	682.917	.287	8.714	8.714	962.960	.404	8.636	1.41	99.713
24	ELECTRICAL POWER	2	587.752	.247	7.500	16.213	897.071	.377	8.045	1.53	99.753
34	NAVIGATION	3	557.166	.234	7.109	23.323	522.108	.219	4.682	.94	99.766
29	HYDRAULIC POWER	4	553.833	.232	7.067	30.389	1022.013	.429	9.165	1.85	99.768
27	FLIGHT CONTROLS	5	534.668	.224	6.822	37.212	929.855	.390	8.339	1.74	99.776
28	FUEL SYSTEMS	6	468.667	.197	5.980	43.192	661.379	.278	5.931	1.41	99.803
52	DOORS	7	434.083	.182	5.539	48.730	424.001	.178	3.802	.98	99.818
72	ENGINE - GENERAL	8	342.549	.144	4.371	53.101	750.158	.315	6.727	2.19	99.856
25	EQUIPMENT/FURNISHINGS	9	310.334	.130	3.960	57.061	221.864	.093	1.990	.71	99.870
36	PNEUMATIC SYSTEM	10	295.868	.124	3.775	60.836	412.743	.173	3.701	1.40	99.876
73	ENGINE FUEL & CONTROL	11	288.036	.121	3.675	64.511	562.067	.236	5.040	1.95	99.879
78	EXHAUST	12	271.616	.114	3.466	67.977	383.541	.161	3.440	1.41	99.886
21	AIR CONDITIONING	13	262.081	.110	3.344	71.321	359.334	.151	3.222	1.37	99.890
33	LIGHTS	14	244.777	.103	3.123	74.445	291.976	.123	2.618	1.18	99.897
22	AUTO FLIGHT	15	229.915	.097	2.934	77.378	217.637	.091	1.952	.95	99.903
77	ENGINE INDICATION	16	227.998	.096	2.909	80.287	374.098	.157	3.355	1.64	99.904
23	COMMUNICATIONS	17	193.722	.081	2.472	82.759	164.818	.069	1.478	.85	99.919
38	WATER/WASTE	18	152.666	.064	1.948	84.707	143.708	.060	1.284	.94	99.936
49	AIRBORNE AUXILIARY POWER	19	148.381	.062	1.893	86.601	110.769	.047	.993	.75	99.938
79	OIL	20	139.901	.059	1.785	88.386	220.895	.093	1.981	1.58	99.941
30	ICE & RAIN PROTECTION	21	131.083	.055	1.673	90.058	144.574	.061	1.297	1.10	99.945
26	FIRE PROTECTION	22	97.642	.041	1.246	91.304	156.571	.066	1.404	1.60	99.954
80	STARTING ENGINE	23	85.334	.036	1.089	92.593	208.294	.087	1.848	2.44	99.964
76	ENGINE CONTROLS	24	83.334	.035	1.063	93.456	138.602	.058	1.243	1.66	99.965
75	ENGINE AIR	25	80.251	.034	1.024	94.480	161.328	.068	1.447	2.01	99.966
71	POWER PLANT GENERAL	26	79.367	.033	1.013	95.493	128.636	.054	1.154	1.62	99.967
54	WINDINGS	27	58.500	.025	.746	96.239	105.681	.044	.948	1.81	99.975
57	WINGS	28	54.000	.023	.689	96.928	94.318	.040	.846	1.75	99.977
74	IGNITION ENGINE	29	53.000	.022	.676	97.605	96.691	.041	.867	1.82	99.978
35	OXYGEN	30	48.333	.020	.617	98.221	40.941	.017	.367	.85	99.980
53	FUSELAGE - GENERAL	31	44.393	.019	.566	98.788	77.046	.032	.691	1.74	99.981
31	INSTRUMENTS	32	34.500	.014	.440	99.228	37.108	.016	.333	1.08	99.986
54	NACELLES/PYLONS STRUCTURE	33	27.000	.011	.345	99.573	34.108	.014	.306	1.26	99.989
05	SPECIAL INSPECTION & CHECK	34	20.000	.008	.255	99.828	70.258	.029	.630	3.51	99.992
55	STABILIZERS	35	13.500	.006	.172	100.000	23.908	.010	.214	1.77	99.994
ALL	AIRCRAFT		7837.167	3.290	100.000		11151.076	4.681	100.000	1.42	96.710

CANCELLATION HOURS ARE BASED ON AVERAGE FLIGHT LENGTH BY AIRLINE

TOTAL REPORTED DEPARTURES FOR THE PERIOD = 238214

LGMD-241 /90-
22/06/90
IN-SERVICE DATA MANAGEMENT

FLEET
DELAYS > 15 MINUTES
DELAY AND CANCELLATION EVENTS FOR THE PERIOD
CHARGEABLE EVENTS
DATA PERIOD: 1 / 1 / 89 THRU 31 / 12 / 89 INCLUSIVE

ATA	DESCRIPTION	EVNT FREQ	FUS NO	A/C MODEL	OPR	EVENT DATE	EVNT TYPE	EVENT LENGTH (HRS)	STATION LOCATION	FLGT NO
242101	83 ENG GENERATOR INOP, REPLACED 83 ENG GENERATOR.	.50	165	-30	A	20/01/89	DLY 46	.89	DALLAS/FT NORTH,	5
242101	83 ENGINE GENERATOR WOULD NOT PARALLEL, REPLACED 83 ENG GENERATOR.	.50	165	-30	B	6/02/89	DLY 46	.36	LOS ANGELES,CALI	73
242101	81 ENG GENERATOR OFF LIGHT ON, UNABLE TO RESET, PLACARDED, LATER, REPLACED 81 ENG GENERATOR.	1.00	51	-10	B	14/05/89	DLY 43	.80	LA GUARDIA,NEW Y	686
242101	83 GENERATOR FAILED ON PUSHOUT, PLACARDED, LATER, REPLACED 83 ENG GENERATOR.	1.00	49	-10	B	18/05/89	DLY 43	.57	ROME, ITALY	85
242101	82 GEN OFF LIGHT ILLUM ON ROLL OUT, PLCD 82 GEN INOP	.25	162	-10	C	4/08/89	DLY 43	.17	CHICAGO, ILLINOIS	235
242101	82 GEN DROPPED OFF LINE, PLACARDED 82 GEN INOP.	.33	319	-10	D	4/08/89	DLY 43	1.28	DENVER, COLORADO	1232

SUMMARY OF EVENTS CONTAINED IN THIS REPORT

OPR	* INCIDENTS	* HOURS	* TOTAL				* TOTAL			
			DELAY	CNX	OTS	SUB	DELAY	CNX	OTS	SUB
A	.00	.50	.00	.50	.00	.00	.00	.89	.00	.89
B	2.50	.00	.00	.00	.00	.00	1.73	.00	.00	1.73
C	.25	.00	.00	.00	.00	.00	.17	.00	.00	.17
D	.33	.00	.00	.00	.00	.00	1.28	.00	.00	1.28
TOTAL	3.08	.50	.00	.50	.00	.00	3.17	.89	.00	4.07

CANCELLATION HOURS ARE BASED ON AVERAGE FLIGHT LENGTH BY AIRLINE

REPORT NO. LGMD-257

A I R C R A F T L O G R E P O R T / A C T I O N T A K E N D E T A I L

ATA/MCL NUMBER	FUSE REPORT NO.	DATE	A T A D E S C R I P T I O N	STA	FLIGHT NUMBER	DEFERRED	DELAY	SOURCE	FINAL ACT DATE	AWTG RPT DAYS
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*** CONTINUED FROM PREVIOUS PAGE ***

CONDITION: NO 2 ENG HAS HIGH OIL CONSUMPTION..

ACTION: ACCOMPLISH LEAK CHECK PER M/M 71-96-18 IF NO LEAKS FOUND ACCOMPLISH LEAK CHECK PER M/M 72-65-00 PAGE 501 AND PAGE 502E CONT DFRD KIT9007 NIS

NS...
COMPUTED ENGINE OIL CONSUMPTION. NR 3 ENG 0.90 PINTS PER HOUR. WITHIN LIMITS PER GPM 8-08 PG 1. NO VISIBLE LKS FOUND
10179AA29 0835 19MAY TUL PRI=1
CPN...KIT9007...QTY 1...***CPN...KITX002...QTY 1...
1...***CPN...KITX003...QTY 1...
CPN...KITX004...QTY 1...***CPN...KITX005...QTY 1...
1...***CPN...KITX006...QTY 1...

920000 1 900519 MISCELLANEOUS

TUL 0 GM 900519 0

CONDITION: SPECIAL ENGINEERING REQUEST

ACTION: VOID-N/A.
10191AA2C 1200 19MAY TUL PRI=1

274000 1 900520 HORIZONTAL STABILIZER

DFW 5 PR 900520 0

CONDITION: THE STAB ALIGNMENT MARK DOES NOT LINE UP WITH THE LONG TRIM SET AT 2DEGREE NOSE UP

ACTION: CKD JACKSCREW MEASUREMENT PER M/M 27-40-00 MUN ET 28-15/16 INCHES PAINT MARKS TO BE CORRECTED ON OVERNITE TECH SERV NOTIFIED COCKPIT IND IN C/ C IS CORRECT
10127AA37 1313 20MAY DFW

274000 1 900520 HORIZONTAL STABILIZER

TUL 0 GM 900520 0

CONDITION: STABILIZER EXTERNAL BLACK STRIPS DO NOT ALIGN AT 2 DEG STAB NOSEUP.

ACTION: MTC IN IAH CONFIRMED STABILIZER POSITION INDICATION IS CORRECT IN THE COCKPIT. ACCOMPLISHED. JACKSCREW MEASUREMENT IN PRIMARY PROCEDURE PER MM 27-40-00 P601. OK TO FLY TO O/N FOR NEW STRIPE. 1. SET STAB TO 2 DEG NOSE UP AND PER PROCEDURES IN MM 27-40-00 P603 STEP 263) PAINT ON NEW STRIPE AS REQUIRED AFTER REMOVING INCORRECT STRIPE.
REMOVED OLD STRIPE REPAINT NEW STRIPE AT 2 DEG NOSE HIGH -UP.
10127AA36 0827 20MAY TUL PRI=1

324300 1 900520 MAIN WHEEL BRAKES

DFW 116 PR 900520 0

CONDITION: SYS 1 BRAKE PRESS GAUGE READS 750PSI AT GATE WITH BOTH AUX HYD PUMPS ON

ACTION: CKED BOTH BRAKE ACCUM AND FOUND SERVICED TO CORRECT PSI. CKED SYS WITH BOTH PUMPS ON AND SYS SW IN ON. FOUND BRAKE PRESS NORMAL APPROVED FOR SER VICE

OPERATOR X -
FLIGHT HOURS:
LANDINGS:

COMPARATIVE MAINTENANCE REQUIREMENTS
REPORT PERIOD : JANUARY 1990 THRU FEBRUARY 1990
LGMD-0256

OPERATOR Y ---
FLIGHT HOURS: 27969
LANDINGS: 8821

SORT - ATA ORDER

OPERATOR X

OPERATOR Y

OPERATOR Y - 4

ATA
MCL
NUM

SYSTEM DESCRIPTION

PILOT COUNT	LOG COUNT	RATE PER 1000 FH	PERCENT TOTAL	RANK	MTDMA
1	1	1000	100	1	100
2	2	500	50	2	50
3	3	333	33	3	33
4	4	250	25	4	25
5	5	200	20	5	20
6	6	167	17	6	17
7	7	143	14	7	14
8	8	125	13	8	13
9	9	111	11	9	11
10	10	100	10	10	10
11	11	91	9	11	9
12	12	83	8	12	8
13	13	77	8	13	8
14	14	71	7	14	7
15	15	67	7	15	7
16	16	63	6	16	6
17	17	59	6	17	6
18	18	56	5	18	5
19	19	53	5	19	5
20	20	50	5	20	5
21	21	48	4	21	4
22	22	45	4	22	4
23	23	43	4	23	4
24	24	42	4	24	4
25	25	40	4	25	4
26	26	38	4	26	4
27	27	37	3	27	3
28	28	36	3	28	3
29	29	34	3	29	3
30	30	33	3	30	3
31	31	32	3	31	3
32	32	31	3	32	3
33	33	30	3	33	3
34	34	29	3	34	3
35	35	28	3	35	3
36	36	27	3	36	3
37	37	26	2	37	2
38	38	25	2	38	2
39	39	24	2	39	2
40	40	23	2	40	2
41	41	22	2	41	2
42	42	21	2	42	2
43	43	20	2	43	2
44	44	19	2	44	2
45	45	18	2	45	2
46	46	17	2	46	2
47	47	16	2	47	2
48	48	15	2	48	2
49	49	14	2	49	2
50	50	13	2	50	2
51	51	12	2	51	2
52	52	11	2	52	2
53	53	10	2	53	2
54	54	9	2	54	2
55	55	9	2	55	2
56	56	8	2	56	2
57	57	8	2	57	2
58	58	7	2	58	2
59	59	7	2	59	2
60	60	6	2	60	2
61	61	6	2	61	2
62	62	5	2	62	2
63	63	5	2	63	2
64	64	4	2	64	2
65	65	4	2	65	2
66	66	3	2	66	2
67	67	3	2	67	2
68	68	2	2	68	2
69	69	2	2	69	2
70	70	1	2	70	2
71	71	1	2	71	2
72	72	1	2	72	2
73	73	1	2	73	2
74	74	1	2	74	2
75	75	1	2	75	2
76	76	1	2	76	2

PILOT COUNT	LOG COUNT	RATE PER 1000 FH	PERCENT TOTAL
1	1	1.00	1.00
2	2	2.00	2.00
3	3	3.00	3.00
4	4	4.00	4.00
5	5	5.00	5.00
6	6	6.00	6.00
7	7	7.00	7.00
8	8	8.00	8.00
9	9	9.00	9.00
10	10	10.00	10.00
11	11	11.00	11.00
12	12	12.00	12.00
13	13	13.00	13.00
14	14	14.00	14.00
15	15	15.00	15.00
16	16	16.00	16.00
17	17	17.00	17.00
18	18	18.00	18.00
19	19	19.00	19.00
20	20	20.00	20.00
21	21	21.00	21.00
22	22	22.00	22.00
23	23	23.00	23.00
24	24	24.00	24.00
25	25	25.00	25.00
26	26	26.00	26.00
27	27	27.00	27.00
28	28	28.00	28.00
29	29	29.00	29.00
30	30	30.00	30.00
31	31	31.00	31.00
32	32	32.00	32.00
33	33	33.00	33.00
34	34	34.00	34.00
35	35	35.00	35.00
36	36	36.00	36.00
37	37	37.00	37.00
38	38	38.00	38.00
39	39	39.00	39.00
40	40	40.00	40.00
41	41	41.00	41.00
42	42	42.00	42.00
43	43	43.00	43.00
44	44	44.00	44.00
45	45	45.00	45.00
46	46	46.00	46.00
47	47	47.00	47.00
48	48	48.00	48.00
49	49	49.00	49.00
50	50	50.00	50.00
51	51	51.00	51.00
52	52	52.00	52.00
53	53	53.00	53.00
54	54	54.00	54.00
55	55	55.00	55.00
56	56	56.00	56.00
57	57	57.00	57.00
58	58	58.00	58.00
59	59	59.00	59.00
60	60	60.00	60.00
61	61	61.00	61.00
62	62	62.00	62.00
63	63	63.00	63.00
64	64	64.00	64.00
65	65	65.00	65.00
66	66	66.00	66.00
67	67	67.00	67.00
68	68	68.00	68.00
69	69	69.00	69.00
70	70	70.00	70.00
71	71	71.00	71.00
72	72	72.00	72.00
73	73	73.00	73.00
74	74	74.00	74.00
75	75	75.00	75.00
76	76	76.00	76.00
77	77	77.00	77.00
78	78	78.00	78.00
79	79	79.00	79.00
80	80	80.00	80.00
81	81	81.00	81.00
82	82	82.00	82.00
83	83	83.00	83.00
84	84	84.00	84.00
85	85	85.00	85.00
86	86	86.00	86.00
87	87	87.00	87.00
88	88	88.00	88.00
89	89	89.00	89.00
90	90	90.00	90.00
91			

05	SPECIAL INSPECTION
10	CLEANING GENERAL
11	PLACARDS
12	SERVICING
21	AIR CONDITIONING
22	AUTO FLIGHT
23	COMMUNICATIONS
24	ELECTRICAL POWER
25	EQUIPMENT / FURNISHINGS
26	FIRE PROTECTION
27	FLIGHT CONTROLS
28	FUEL SYSTEM
29	HYDRAULIC POWER
30	ICE / RAIN PROTECTION
31	INSTRUMENTS
32	LANDING GEAR
33	LIGHTS
34	NAVIGATION
35	OXYGEN
36	PNEUMATIC SYSTEM
38	WATER / WASTE
39	AIRBORNE AUX POWER
52	DOORS
53	FUSELAGE
54	NACELLES/PYLONS STRUCTURE
55	STABILIZERS
56	WINDINGS
57	WINGS
71	ENGINE POWER PLANT
72	ENGINE
73	ENG FUEL AND CONTROL
74	IGNITION ENGINE
75	ENGINE AIR
76	ENGINE CONTROLS
77	ENGINE INDICATING
78	EXHAUST
79	OIL
80	STARTING ENGINE
92	MISCELLANEOUS

2	34	0.06249	0.02	37	941
249	819	7.78052	2.09	14	39
102	0	0.00000	0.00	58	0
457	103	3.18720	0.86	26	310
815	662	14.27991	3.84	7	48
1240	1406	25.46636	6.85	5	22
371	2451	38.74636	10.42	13	13
2145	488	11.59266	3.12	9	65
2145	4634	6.702496	18.03	1	6
183	326	5.71821	1.54	19	98
256	329	7.99925	2.15	13	94
226	305	7.06183	1.90	16	104
199	258	6.21816	1.67	17	124
152	245	4.74955	1.28	21	130
55	70	1.71858	0.66	29	457
186	355	8.93666	2.40	11	90
1340	3258	41.87107	11.26	2	9
821	1025	25.65384	6.90	4	31
232	257	7.24932	1.95	15	124
331	538	10.34278	2.78	10	59
424	994	13.24875	3.56	8	32
285	464	8.90541	2.39	12	68
565	864	17.65459	4.75	6	37
71	109	2.21854	0.60	28	293
21	26	0.65618	0.18	34	1230
3	7	0.09374	0.03	36	4571
118	141	3.68715	0.99	23	226
28	50	0.87491	0.24	32	640
26	46	0.81242	0.22	33	695
29	119	3.49967	0.94	31	268
43	72	1.34362	0.36	25	176
8	11	2.56225	0.07	30	444
82	130	3.59341	0.69	35	2909
1157	153	4.28084	0.97	27	246
153	392	4.78080	1.15	22	209
153	211	4.90616	1.29	20	81
189	34	5.90569	1.59	31	151
	362			18	941
					88

55	514	1.96666	0.32
0	0	0.00000	0.00
57	143	2.03797	0.33
0	0	0.00000	0.00
606	754	21.66684	3.52
539	652	19.27133	3.13
1750	2183	62.56927	10.16
250	591	8.93846	1.45
5937	8062	212.27072	34.48
134	378	4.79101	0.78
227	376	8.11612	1.32
267	689	9.54628	1.55
204	456	7.29378	1.18
134	224	4.79101	0.78
28	589	1.00110	0.16
149	3099	5.32732	0.87
2676	5824	95.67735	15.54
801	1043	28.63885	4.65
298	841	10.65465	1.73
298	456	10.65465	1.73
861	1104	30.78408	5.00
222	723	7.93735	1.29
207	1105	7.40105	1.20
31	256	1.10836	0.18
8	194	0.28603	0.05
2	51	0.07150	0.01
115	143	4.11169	0.67
11	170	0.39329	0.06
7	281	0.25027	0.04
800	4420	28.60309	4.65
86	180	3.07483	0.50
101	135	3.61114	0.59
15	78	0.53630	0.09
57	99	2.03797	0.33
79	128	2.82455	0.46
141	304	5.04129	0.82
25	53	0.89384	0.15
32	55	1.14412	0.19
10	42	0.35753	0.06

1.458726 17220 33859 615.68162 100.00

APPENDIX J

HUGHES RADAR SPECIFICATIONS

Hughes Radar Systems

System	Year of Intro.	Weight (lbs)	vol. (ft³)	LRU's	SRU's	Electrical Comp.	Active Comp.	Reliability MFT/Ver. failure (hrs)
F14A(AWG-9WCS)*	73	1260	28.4	26	553	38,369	12,410	7
F15(APG 63)	74	516	9.0	9	125	19,255	8,529	25
F18(APG 65)	81	346	10.2	5	67	13,500	6,000	75
F15E(APG 70)	87	564	8.7	8	102	15,946	5,726	40

• AWG 9 WCS is only complete weapons system the others are just radar systems.

AWG 9 WCS was developed for the F108 (mid 60's) and the Navy wanted it for the F14A.

APPENDIX K

CONTACTS

Government:**FAA**

Operations Systems Branch, AVN-120
PO Box 25082
Oklahoma City, Oklahoma 73125

US Air Force:

Rome Laboratory/ERSR (MIL HNDBK-217)
Griffiss AFB, NY 13441-5700

Aeronautical Systems Division/ENACR (System Reliability)
Wright-Patterson AFB, OH 45433

HQ Air Force Logistics Command/ENIS (MODAS & REMIS)
WPAFB, OH 45433

Acquisition Logistics Division (ALD Pamphlet 800-4)
WPAFB, OH 45433

Aeronautical Systems Division/ENSSC (LCOM)
WPAFB, OH 45433

Reliability Analysis Center (RAC)
PO Box 4700
Rome, NY 13440-8200

Naval Air Systems Command (AIR-4114)
Washington, DC 20361

Naval Maintenance Support Office
Naval Sea Logistics Center, Code 61
5450 Carlisle Pike
PO Box 2060
Mechanicsburg, PA 17055-0795

Commercial:

Airbus Industrie of North America
593 Herndon Parkway
Herndon, VA 22070

American Institute of Aeronautics and Astronautics (AIAA)
37 L'Enfant Promenade SW
Washington, DC 20024

Commercial (continued)

Boeing Commercial Air Planes
PO Box 3707
Seattle, WA 98124

Boeing Computer Services
7990 Boeing Court
Vienna, VA 22182-3999

Douglas Aircraft Company
3855 Lakewood Blvd.
Long Beach, CA 90846

E-Systems
PO Box 1056
Greenville, TX 75401

Harris Corporation
4141 Col. Glenn
Dayton, OH 45431

Harris Corporation
Government Aerospace Systems Division
PO Box 9400
Melbourne, FL 32902

Hughes Aircraft Company
Radar Systems Group
PO Box 92426
Los Angeles, CA 90009

Society of Automotive Engineers (SAE), Inc.
400 Commonwealth Dr.
Warrendale, PA 15096-0001

United Airlines
San Francisco International Airport (MOC/SF Airport)
San Francisco, CA 91428

US Air
173 Industry Dr.
Pittsburgh, PA 15275

APPENDIX L

REGRESSION ANALYSIS

NASA - AIRFRAME WUC 11 VOL VI MEAN FLYING HRS/MA
REGRESSION FUNCTION & ANOVA FOR FH/MA

FH/MA = 23.22925 - 0.111771 CEILING + 12.6007 WG AREA
- 0.0576 LENGTH - 0.005075 YR
- 21.97399 SQR WING - 0.684188 WING^2

R-Squared = 0.86312
Adjusted R-Squared = 0.824011
Standard error of estimate = 0.892543
Number of cases used = 28

Analysis of Variance

Source	SS	df	MS	F Value	Sig Prob
Regression	105.48950	6	17.58158	22.06984	0.000000
Residual	16.72930	21	0.79663		
Total	122.21880	27			

NASA - AIRFRAME WUC 11 VOL VI MEAN FLYING HRS/MA
REGRESSION COEFFICIENTS FOR FH/MA

Variable	Coefficient	Std Error	t Value	Two-Sided Sig Prob
Constant	23.22925	2.73826	8.48323	0.000000
CEILING	-0.11177	0.01871	-5.97400	0.000006
WG AREA	12.60070	2.13428	5.90396	0.000007
LENGTH	-0.05760	0.02039	-2.82506	0.010143
YR	-0.00508	0.02758	-0.18404	0.855748 *
SQR WING	-21.97399	3.89834	-5.63676	0.000014
WING^2	-0.68419	0.15520	-4.40857	0.000245

* indicates that the variable is marked for leaving

Standard error of estimate = 0.892543
Durbin-Watson statistic = 2.541273

NASA - AIRFRAME WUC 11 MAN-HOURS PER FLYING HOUR
REGRESSION FUNCTION & ANOVA FOR MMH/FH

$$\text{MMH/FH} = -4.953856 - 0.01547 \text{ TO-WGT} + 0.051091 \text{ CEILING} \\ - 2.934957 \text{ WG AREA} + 0.33163 \text{ SQR TOWGT} \\ + 5.518674 \text{ SQR WING} + 0.357075 \text{ WING}^2$$

R-Squared = 0.897902
Adjusted R-Squared = 0.875213
Standard error of estimate = 0.314785
Number of cases used = 34

Analysis of Variance

Source	SS	df	MS	F Value	Sig Prob
Regression	23.52889	6	3.92148	39.57510	0.000000
Residual	2.67542	27	0.09909		
Total	26.20431	33			

NASA - AIRFRAME WUC 11 MAN-HOURS PER FLYING HOUR
REGRESSION COEFFICIENTS FOR MMH/FH

Variable	Coefficient	Std Error	t Value	Two-Sided Sig Prob
Constant	-4.95386	0.66707	-7.42626	0.000000
TO-WGT	-0.01547	0.00408	-3.79119	0.000767
CEILING	0.05109	0.00590	8.66663	0.000000
WG AREA	-0.93496	0.96563	-3.03943	0.005215
SQR TOWGT	0.33163	0.15647	2.11946	0.043392
SQR WING	5.51867	2.42052	2.27996	0.030728
WING^2	0.35707	0.05155	6.92612	0.000000

Standard error of estimate = 0.314785
Durbin-Watson statistic = 2.598312

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NASA - LANDING GEAR WUC 13xxx MEAN FLYING HRS BTWN MA
 REGRESSION FUNCTION & ANOVA FOR MFH/MA

MFH/MA = 23.86407 - 1.409666 SQR LENGTH

R-Squared = 0.815936
 Adjusted R-Squared = 0.809119
 Standard error of estimate = 2.099274
 Number of cases used = 29

Analysis of Variance

Source	SS	df	MS	F Value	Sig Prob
Regression	527.46120	1	527.46120	119.68840	0.000000
Residual	118.98770	27	4.40695		
Total	646.44890	28			

NASA - LANDING GEAR WUC 13xxx MEAN FLYING HRS BTWN MA
 REGRESSION COEFFICIENTS FOR MFH/MA

Variable	Coefficient	Std Error	t Value	Two-Sided Sig Prob
Constant	23.86407	1.40073	17.03687	0.000000
SQR LENGTH	-1.40967	0.12885	-10.94022	0.000000

Standard error of estimate = 2.099274
 Durbin-Watson statistic = 1.518892

NASA - LANDING GEAR WUC 13xxx MAINT MAN-HRS PER FLY HR
 REGRESSION COEFFICIENTS FOR MMH/FH

Variable	Coefficient	Std Error	t Value	Two-Sided Sig Prob
Constant	-53.66402	23.81530	-2.25334	0.036946
LOG YR	17.08925	7.37032	2.31866	0.032380
YEAR	-0.26797	0.10740	-2.49516	0.022534
SQR LENGTH	0.09412	0.01528	6.16133	0.000008

Standard error of estimate = 0.190247
 Durbin-Watson statistic = 2.144961

NASA - ELEC PWR SYS WUC 42xxx MEAN FLYING HRS/MA
 REGRESSION FUNCTION & ANOVA FOR MFH/MA

MFH/MA = - 271.444 - 0.212449 TO-WGT + 0.533079 CEILING
 - 0.768166 YR + 28.35901 SQR LENGTH
 + 7697.175 1/LENGTH

R-Squared = 0.790956
 Adjusted R-Squared = 0.747405
 Standard error of estimate = 9.591888
 Number of cases used = 30

Analysis of Variance

Source	SS	df	MS	F Value	Sig Prob
Regression	8354.74600	5	1670.94900	18.16164	0.000000
Residual	2208.10400	24	92.00432		
Total	10562.85000	29			

NASA - ELEC PWR SYS WUC 42xxx MEAN FLYING HRS/MA
 REGRESSION COEFFICIENTS FOR MFH/MA

Variable	Coefficient	Std Error	t Value	Two-Sided Sig Prob
Constant	-271.44400	72.83025	-3.72708	0.001047
TO-WGT	-0.21245	0.04830	-4.39864	0.000192
CEILING	0.53308	0.20267	2.63033	0.014662
YR	-0.76817	0.30845	-2.49041	0.020078
SQR LENGTH	28.35901	6.74457	4.20472	0.000314
1/LENGTH	7697.17500	1570.56900	4.90088	0.000053

Standard error of estimate = 9.591888
 Durbin-Watson statistic = 1.138776

NASA - ELEC PWR SYS WUC 42xxx MAINT MAN-HOURS PER FLY HRS
 REGRESSION FUNCTION & ANOVA FOR MMH/FH

$$\text{MMH/FH} = 11.30551 + 0.001867 \text{ EMPTY-WGT} + 0.263477 \text{ CEILING} \\
 - 3.450736 \text{ SQR CEIL}$$

R-Squared = 0.869046
 Adjusted R-Squared = 0.854496
 Standard error of estimate = 0.076739
 Number of cases used = 31

Analysis of Variance

Source	SS	df	MS	F Value	Sig Prob
Regression	1.05516	3	0.35172	59.72651	0.000000
Residual	0.15900	27	0.00589		
Total	1.21415	30			

NASA - ELEC PWR SYS WUC 42xxx MAINT MAN-HOURS PER FLY HRS
REGRESSION COEFFICIENTS FOR MMH/FH

Variable	Coefficient	Std Error	t Value	Two-Sided Sig Prob
Constant	11.30551	1.90648	5.93005	0.000002
EMPTY-WGT	0.00187	1.46506E-04	12.74554	0.000000
CEILING	0.26348	0.04256	6.19022	0.000001
SQR CEIL	-3.45074	0.57345	-6.01754	0.000002

Standard error of estimate = 0.076739

Durbin-Watson statistic = 2.071562

NASA - HYDRAULICS SYS WUC 45xxx MEAN FLY-HRS BTWN MA
REGRESSION FUNCTION & ANOVA FOR MFH/MA

MFH/MA = 49.40489 + 0.369793 TO-WGT - 0.49955 EMPTY-WGT
+ 39.86846 WG AREA - 0.620174 LENGTH
+ 1.240129 YR + 22.75922 MISSION
- 157.5092 SQR WING

R-Squared = 0.890941
Adjusted R-Squared = 0.860404
Standard error of estimate = 10.52203
Number of cases used = 33

Analysis of Variance

Source	SS	df	MS	F Value	Sig Prob
Regression	22611.26000	7	3230.18000	29.17612	0.000000
Residual	2767.82800	25	110.71310		
Total	25379.09000	32			

NASA - HYDRAULICS SYS WUC 45xxx MEAN FLY-HRS BTWN MA
 REGRESSION COEFFICIENTS FOR MFH/MA

Variable	Coefficient	Std Error	t Value	Two-Sided Sig Prob
Constant	49.40489	22.09663	2.23586	0.034527
TO-WGT	0.36979	0.07613	4.85717	0.000054
EMPTY-WGT	-0.49955	0.17883	-2.79337	0.009862
WG AREA	39.86846	7.85063	5.07837	0.000030
LENGTH	-0.62017	0.31237	-1.98536	0.058177
YR	1.24013	0.33120	3.74437	0.000952
MISSION	22.75922	3.16591	7.18885	0.000000
SQR WING	-157.50920	23.47045	-6.71096	0.000000

Standard error of estimate = 10.52203
 Durbin-Watson statistic = 2.047476

NASA - HYDRAULICS SYS WUC 45xxx MAINT MAN-HRS/ FLYING HR
REGRESSION FUNCTION & ANOVA FOR MMH/FH

$$\begin{aligned} \text{MMH/FH} = & 0.926234 + 0.010833 \text{ CEILING} - 0.586775 \text{ WG AREA} \\ & + 0.014184 \text{ LENGTH} - 0.008041 \text{ YR} \\ & - 0.051832 \text{ MISSION} + 1.779134 \text{ SQR WING} \\ & - 0.306858 \text{ SQR LENGTH} \end{aligned}$$

R-Squared = 0.800059
Adjusted R-Squared = 0.748222
Standard error of estimate = 0.082175
Number of cases used = 35

Analysis of Variance

Source	SS	df	MS	F Value	Sig Prob
Regression	0.72955	7	0.10422	15.43423	0.000000
Residual	0.18232	27	0.00675		
Total	0.91188	34			

NASA - HYDRAULICS SYS WUC 45xxx MAINT MAN-HRS/ FLYING HR
REGRESSION COEFFICIENTS FOR MMH/FH

Variable	Coefficient	Std Error	t Value	Two-Sided Sig Prob
Constant	0.92623	0.60164	1.53950	0.135320
CEILING	0.01083	0.00219	4.95746	0.000034
WG AREA	-0.58678	0.12768	-4.59571	0.000090
LENGTH	0.01418	0.00688	2.06238	0.048914
YR	-0.00804	0.00270	-2.97683	0.006081
MISSION	-0.05183	0.03011	-1.72139	0.096621
SQR WING	1.77913	0.32371	5.49606	0.000008
SQR LENGTH	-0.30686	0.13465	-2.27889	0.030800

Standard error of estimate = 0.082175
Durbin-Watson statistic = 1.770126

NASA - OXYGEN SYS WUC 47xxx MEAN FLYING HRS PER MA
REGRESSION FUNCTION & ANOVA FOR MFH/MA

MFH/MA = 260.1071 + 0.213175 TO-WGT + 18.61948 MISSION
- 61.79837 SQR WING - 19.19873 SQR LENGTH

R-Squared = 0.723401
Adjusted R-Squared = 0.688826
Standard error of estimate = 24.73121
Number of cases used = 37

Analysis of Variance

Source	SS	df	MS	F Value	Sig Prob
Regression	51188.02000	4	12797.01000	20.92269	0.000000
Residual	19572.25000	32	611.63280		
Total	70760.27000	36			

NASA - OXYGEN SYS WUC 47xxx MEAN FLYING HRS PER MA
 REGRESSION COEFFICIENTS FOR MFH/MA

Variable	Coefficient	Std Error	t Value	Two-Sided Sig Prob
Constant	260.10710	40.77314	6.37937	0.000000
TO-WGT	0.21318	0.06735	3.16517	0.003392
MISSION	18.61948	6.67361	2.79002	0.008808
SQR WING	-61.79837	34.14871	-1.80968	0.079747
SQR LENGTH	-19.19873	7.55555	-2.54101	0.016101

Standard error of estimate = 24.73121
 Durbin-Watson statistic = 1.170085

NASA - OXYGEN SYS WUC 47xxx MAINT MAN-HRS/ FLYING HR
 REGRESSION FUNCTION & ANOVA FOR MMH/FH

MMH/FH = 0.452033 - 0.011884 MISSION - 4.298343 1/LENGTH
 - 0.036333 SQR YR

R-Squared = 0.629656
 Adjusted R-Squared = 0.591345
 Standard error of estimate = 0.023763
 Number of cases used = 33

Analysis of Variance

Source	SS	df	MS	F Value	Sig Prob
Regression	0.02784	3	0.00928	16.43521	0.000001
Residual	0.01638	29	5.64686E-04		
Total	0.04422	32			

NASA - OXYGEN SYS WUC 47xxx MAINT MAN-HRS/ FLYING HR
 REGRESSION COEFFICIENTS FOR MMH/FH

Variable	Coefficient	Std Error	t Value	Two-Sided Sig Prob
Constant	0.45203	0.08086	5.59023	0.000004
MISSION	-0.01188	0.00612	-1.94260	0.061832
1/LENGTH	-4.29834	0.88130	-4.87730	0.000036
SQR YR	-0.03633	0.00912	-3.98282	0.000419

Standard error of estimate = 0.023763
 Durbin-Watson statistic = 2.446844

APPENDIX M

BASIC PROGRAM FOR DATA ANALYSIS

Appendix M

Basic Program for Data Analysis

AFALDP 800-4

```
10 'PROGRAM COMBINES 6 MONTH DATA FROM ALDP 800-4
20 'COMPUTES R&M STATS FOR VARIOUS 2-DIGIT WUC'S
30 KEY OFF:CLS:COLOR 3
40 PRINT TAB(20) "CALCULATION OF AIRCRAFT R&OOM PARAMETERS"
50 PRINT:PRINT
60 DIM MTBM(10,10),MMH(10,10),WUC$(10)
70 FOR J=1 TO 5
80 READ WUC$(J)
90 NEXT J
100 INPUT "ENTER AIRCRAFT";AC$
110 INPUT "ENTER NUMBER OF 6-MONTH INTERVALS";NUM
120 FOR I=1 TO NUM
130 PRINT "ENTER FLYING HOURS FOR ";I;"6-MONTH PERIOD"
140 INPUT FH(I)
150 PRINT "ENTER SORTIES FOR ";I;"6-MONTH PERIOD"
160 INPUT S(I)
170 PRINT "ENTER LANDINGS FOR ";I;"6-MONTH PERIOD"
180 INPUT L(I)
190 FOR J=1 TO 5
200 PRINT "ENTER MTBM FOR";WUC$(J)
210 INPUT MTBM(I,J)
220 PRINT "ENTER ON-EQUIP MMH FOR";WUC$(J)
230 INPUT MMH(I,J)
240 PRINT "ENTER OFF-EQUIP MMH FOR";WUC$(J)
250 INPUT OMMH(I,J)
260 PRINT
270 NEXT J
280 NEXT I
290 CLS:COLOR 2
300 PRINT TAB(20) "OUTPUT RESULTS FOR ";AC$
310 LPRINT TAB(20) "OUTPUT RESULTS FOR ";AC$
320 PRINT
330 LPRINT
340 FOR I=1 TO NUM
350 TFH=TFH+FH(I)
360 TS=TS+S(I)
370 TL=TL+L(I)
375 NEXT I
380 PRINT TAB(10) "TOT FLYING-HRS";TAB(40) TFH
390 LPRINT TAB(10) "TOT FLYING-HRS";TAB(40) TFH
400 PRINT TAB(10) "TOT SORTIES";TAB(40) TS
410 LPRINT TAB(10) "TOT SORTIES";TAB(40) TS
420 PRINT TAB(10) "TOT LANDINGS";TAB(40) TL
430 LPRINT TAB(10) "TOT LANDINGS";TAB(40) TL
440 PRINT:LPRINT
450 FOR J=1 TO 5
460 FOR I=1 TO NUM
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470 TMAINT(J)=TMAINT(J)+(1/MTBM(I,J))*FH(I)
480 TMMH(J)=TMMH(J)+MMH(I,J)
490 TOMMH(J)=TOMMH(J)+OMMH(I,J)
500 NEXT I
510 TOTMH(J)=TMMH(J)+TOMMH(J)
520 MFHBM(J)=TFH/TMAINT(J)
530 MSBM(J)=TS/TMAINT(J)
540 MLBM(J)=TL/TMAINT(J)
550 MHFH(J)=TOTMH(J)/TFH
560 MHS(J)=TOTMH(J)/TS
570 PRINT:PRINT
580 LPRINT:LPRINT
590 PRINT TAB(10) "WUC ";WUC$(J):PRINT
600 LPRINT TAB(10) "WUC ";WUC$(J):LPRINT
610 PRINT TAB(15) "TOTAL MAINTENANCE EVENTS"; TAB(50) TMAINT(J)
620 LPRINT TAB(15) "TOTAL MAINTENANCE EVENTS"; TAB(50) TMAINT(J)
630 PRINT TAB(15) "TOTAL MAINTENANCE MANHOURS";TAB(50) TOTMH(J)
640 LPRINT TAB(15) "TOTAL MAINTENANCE MANHOURS";TAB(50) TOTMH(J)
650 PRINT TAB(20) "TOTAL ON-EQUIP MAINT";TAB(50) TMMH(J)
660 LPRINT TAB(20) "TOTAL ON-EQUIP MAINT";TAB(50) TMMH(J)
670 PRINT TAB(20) "TOTAL OFF-EQUIP MAINT";TAB(50) TOMMH(J)
680 LPRINT TAB(20) "TOTAL OFF-EQUIP MAINT";TAB(50) TOMMH(J)
690 PRINT:COLOR 12
700 LPRINT
710 PRINT TAB(15) "MEAN FLYING HR BTWN MAINT";TAB(50) MFHBM(J)
720 LPRINT TAB(15) "MEAN FLYING HR BTWN MAINT";TAB(50) MFHBM(J)
730 PRINT TAB(15) "MEAN SORTIES BTWN MAINT";TAB(50) MSBM(J)
740 LPRINT TAB(15) "MEAN SORTIES BTWN MAINT";TAB(50) MSBM(J)
750 PRINT TAB(15) "MEAN LANDINGS BTWN MAINT";TAB(50) MLBM(J)
760 LPRINT TAB(15) "MEAN LANDINGS BTWN MAINT";TAB(50) MLBM(J)
770 PRINT TAB(15) "MAN-HOURS PER FLY-HR";TAB(50) MHFH(J)
780 LPRINT TAB(15) "MAN-HOURS PER FLY-HR";TAB(50) MHFH(J)
790 PRINT TAB(15) "MAN-HOURS PER SORTIE";TAB(50) MHS(J)
800 LPRINT TAB(15) "MAN-HOURS PER SORTIE";TAB(50) MHS(J)
810 PRINT:LPRINT
820 MHPF(J)=TOTMH(J)/TMAINT(J)
830 MHPFON(J)=TMMH(J)/TMAINT(J)
840 OMHPF(J)=TOMMH(J)/TMAINT(J)
850 PRINT TAB(15) "MAN-HOURS PER MAINT ACTION";TAB(50) MHPF(J)
860 LPRINT TAB(15) "MAN-HOURS PER MAINT ACTION";TAB(50) MHPF(J)
870 PRINT TAB(20) "ON-EQUIP MAN-HRS/MAINT ACTION";TAB(50) MHPFON(J)
880 LPRINT TAB(20) "ON-EQUIP MAN-HRS/MAINT ACTION";TAB(50) MHPFON(J)
890 PRINT TAB(20) "OFF-EQUIP MAN-HRS/MAINT ACTION";TAB(50) OMHPF(J)
900 LPRINT TAB(20) "OFF-EQUIP MAN-HRS/MAINT ACTION";TAB(50) OMHPF(J)
910 PRINT
915 LPRINT:LPRINT
920 NEXT J
930 COLOR 3
935 GOSUB 1000
940 END

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950 DATA 11-AIRFRAME
960 DATA 13-LAND-GEAR
970 DATA 42-ELEC-PWR
980 DATA 45-HYDRAULICS
990 DATA 47-OX-SYS
1000 ' SUBROUTINE TO PROVIDE ECHO CHECK
1010 LPRINT:LPRINT:LPRINT TAB(20) "ECHO CHECK OF INPUT DATA":LPRINT
1020 LPRINT TAB(1) "PERIOD";TAB(20) "MTBM";TAB(36) "ON-EQUIP MH";TAB(50) "OFF-EQ
UIP MH":LPRINT
1030 FOR J=1 TO 5
1040 LPRINT:LPRINT TAB(10) WUC$(J)
1050 FOR I=1 TO NUM
1060 LPRINT TAB(1) I;TAB(20) MTBM(I,J);TAB(36) MMH(I,J);TAB(50) OMMH(I,J)
1070 NEXT I
1080 LPRINT
1090 NEXT J
1100 LPRINT:LPRINT TAB(20) "VALIDATION CHECK":LPRINT
1120 LPRINT TAB(1) "PERIOD";TAB(20) "ON-EQUIP MH/FH";TAB(50) "OFF-EQUIP MH/FH":L
PRINT
1130 FOR J=1 TO 5
1140 LPRINT:LPRINT TAB(10) WUC$(J)
1150 FOR I=1 TO NUM
1160 LPRINT TAB(1) I;TAB(20) MMH(I,J)/FH(I);TAB(50) OMMH(I,J)/FH(I)
1170 NEXT I
1180 LPRINT
1190 NEXT J
1200 RETURN
```